WARNING - DANGEROUS VOLTAGES

VOLTAGE LEVELS WITHIN THIS PRODUCT CAN EXCEED 120 VAC AND 100 VDC. THESE VOLTAGE LEVELS CAN CAUSE SERIOUS INJURY OR BE FATAL, THEREFORE FOLLOW GOOD ELECTRICAL PRACTICES, APPLICABLE ELECTRICAL CODES AND THE CONTENTS OF THIS MANUAL.

Due to the wide variety of uses for the 5440, it is the responsibility of the user or those applying the unit to determine the suitability of this product for any intended application. In no event will Pacific Scientific Company be responsible or liable for indirect or consequential damage resulting from the use of this product.

The figures, tables, and examples shown in this manual are intended solely to supplement the text. Because of the varied requirements of any particular application, Pacific Scientific Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications included in this manual.

MODEL 5440 INSTRUCTION MANUAL
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LIST OF FIGURES

SECTION 1

INTRODUCTION

1.1 General

This manual outlines Specifications, Features, Installation/Set-up and Programming for Pacific Scientific's Model 5440 Stepping Motor Indexer/Driver Package.

This package is designed for use with Pacific Scientific's SIGMA Line of hybrid stepping motors. The package will control either the standard SIGMA Line hybrid stepping motors or the high-performance SIGMAX enhanced hybrid stepping motors. These motors are two phase.

1.2 Overview of Operation

Figure 1.1 is a functional block diagram of the 5440. The package contains a programmable indexer and a two phase bipolar chopper driver along with associated power supplies to operate the package directly from 120 VAC.

The microstepping motor driver is a high efficiency bipolar chopper utilizing Pulse Width Modulation to electronically control the motor winding currents. The microstep size is set by dip switches. The power stages are protected against overheating and phase-to-phase and phase to ground short circuits. The presence of a short circuit is indicated by the DISABLE led on the front panel. The short circuit detector clears automatically when the fault is cleared.

An Idle Current Reduction (ICR) feature allows motor winding currents to be automatically reduced by 50% during motor dwell periods. ICR begins one second after the last input step pulse occurs, and may be enabled or disabled by a circuit board jumper.

The driver has additional circuitry to eliminate midrange frequency instability. Midrange instability can be explained as a region of potential instability that occurs as a result of the electronic, magnetic, and mechanical characteristics of any stepping motor system. The circuitry used to control this phenomenon does so by advancing or delaying the switching of the output transistors with respect to the incoming pulse train. This should be taken into account if the user is attempting to employ pulse placement techniques. The midrange stability feature can be enabled or disabled by the user with a circuit board jumper.

Pulse and direction information for the driver are generated by the indexer and are optically isolated. The indexer is programmed via an RS-232 serial port or through an 8 bit parallel interface. Over 500 bytes of non-volatile memory are provided for program storage. Baud rate for the RS-232 serial link is selected via jumpers.

Dedicated I/O is provided along with user programmable I/O. The dedicated I/O includes Jog inputs, Remote Stop and start inputs, Home switch input, and Status outputs. The programmable I/O consists of five inputs and five outputs.

The 5440 can be operated in either programmed mode or immediate mode. In immediate mode, commands are executed as soon as they are received. In programmed mode, commands are stored in the non-volatile memory and are executed by "running" the program.

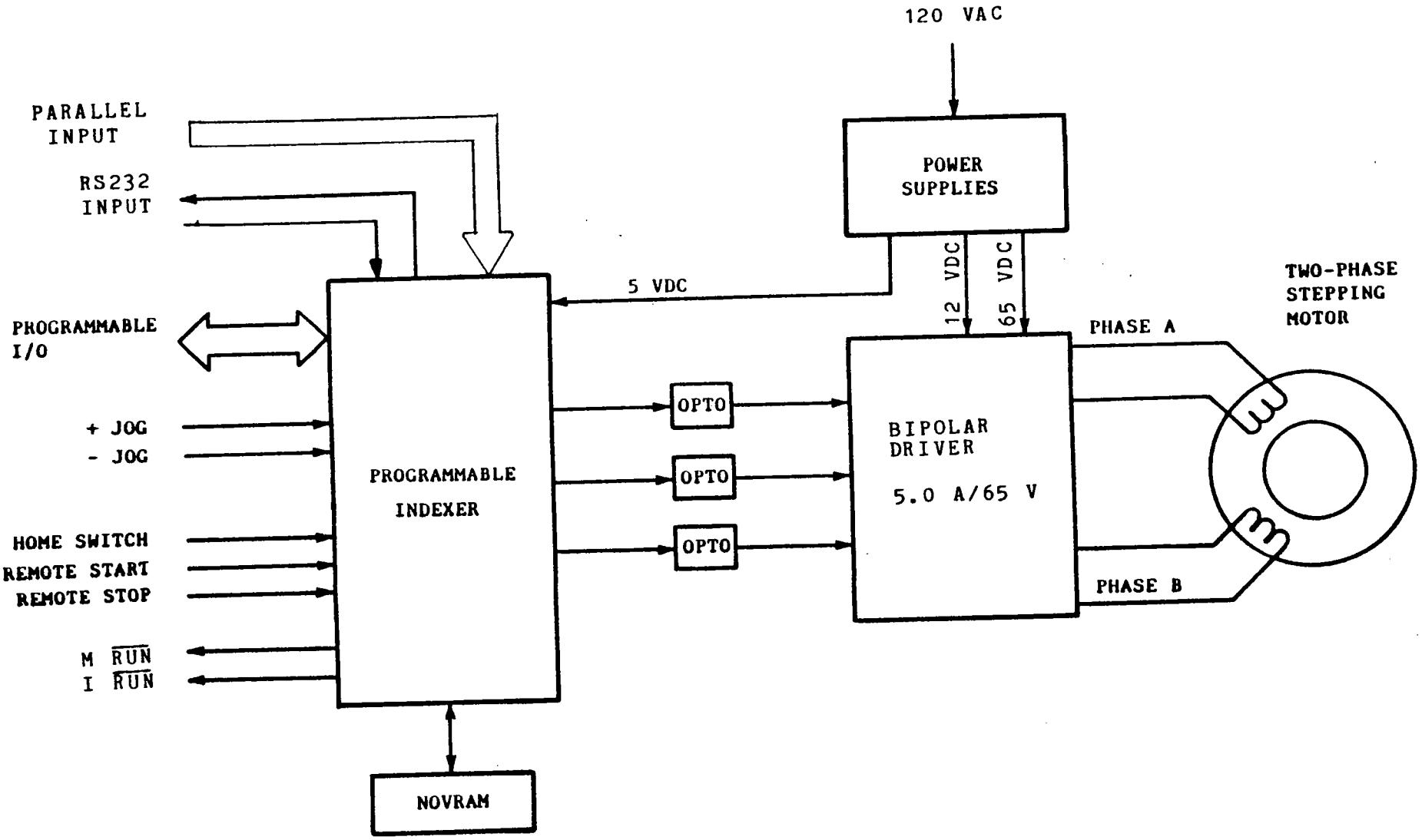
The set of commands is diverse and allows the user to program a wide range of motion profiles. The commands include both incremental and absolute position moves with trapezoidal velocity profiles. The acceleration/deceleration and maximum velocity parameters are user programmable. A constant velocity command is also available.

The indexer is programed in blocks with conditional and unconditional jump commands from one program block to another allowing complex move profiles to be integrated with I/O. The programmable I/O also allows the indexer to interface to other pieces of equipment such as programmable logic controllers, limit switches or any system generating discrete I/O. In some applications the 5440 I/O may control the entire process.

Homing commands allow the user to incorporate a home limit switch into their equipment for use as an absolute mechanical reference point. Scan commands can set up 2 general purpose inputs to act as limit switches.

1.3 Features

- RS-232 serial communications interface
- 8 bit parallel interface for PLC's
- Microprocessor-based design
- Non-volatile memory for program storage
- Five programmable inputs and outputs
- Optical isolation for improved noise immunity
- Integrated package for ease of installation and use



FUNCTIONAL BLOCK DIAGRAM

FIGURE 1.1

SECTION 2

SPECIFICATIONS

2.1 General

Step Size :	Full, 1/2, 1/5, 1/25, 1/125 selected via Dip Switches
Velocity :	25 to 20,000 Full Steps/Sec in Full, 1/2, 1/5 step 25 to 10,000 Full Steps/Sec in 1/25 Step Mode 5 to 2,000 Full Steps/Sec in 1/125 Step Mode The output pulse rate is the velocity, entered in full steps per second, multiplied by the indexer's "microstep-per-step" factor which can be selected to be 1(full), 2, 5, or 25 (Note: the 5440 driver can be setup to have 125 microsteps-per-step. In that case, the indexer should be set to 25 microsteps-per-step with the understanding that the motor velocity in steps/sec will be 1/5th the programmed value.). Velocities are rounded off to the nearest multiple of 25 (Example: 146 to 150, 77 to 75, 491 to 500, etc.)
Distance :	1 to 9,999,999 Steps in 1 step increments, of the selected step size.
Linear Acceleration Deceleration Time :	0.01 to 9.99 seconds in 0.01 second increments. (Max. rate is 10 Khz in 0.05 seconds; since this is linear ramp, note that at 20 KHz, the increment is 0.10 seconds. Also, the slowest possible rate is to 4 Khz in 5 seconds.)

Start/stop Velocity :	25 to 999 full-steps per second, rounded off to 25 (Pulse rate is velocity multiplied by Step Size switch setting on Indexer).
Cycle Counter :	1 to 65535 (the cycle counter allows a move to be repeated a specified number of times); The X command is interpreted as infinite cycle count.
Move Profiles :	Index, move to absolute position, run at speed, cycle, seek mechanical home, seek electrical home.
Operational Modes :	Immediate or Program Immediate: Data entered are operated on immediately when a Go command ("G") is issued. Program: Operating parameter are read and loaded from user's program when a "RUN" command is received. Multiple moves can be pre-programmed and stored permanently in non-volatile memory.
Programmable Inputs :	5 input bits or external events. These inputs can be read individually or in combination (input codes 0 through 31).
Programmable Outputs :	5 bit general purpose output lines can be set to logic high or logic low at any time.
Programmable Dwell Time :	.001 to 65.5 seconds in .001 second increments.
Position Counter :	0 +/- 16,777,000
Status Report :	Reports over the serial link internal indexer status and I/O conditions when requested.

Serial Interface :

Type	RS232
Baud Rate	300, 600, 1200, 2400, 4800, 9600 (jumper selectable)
Parity	None
Data Word	10 bit (1 start, 8 data, 1 stop)

Parallel Interface :

Type	7 bit parallel ASCII data word with 1 bit strobe.
Data Rate	250 HZ maximum strobe rate

2.2 Electrical

Input Voltage :	120 VAC (+ 10%, - 15%) Single Phase, 60 HZ
Input Fuse :	MDA6
Input Current :	5.0 Amp RMS maximum
Drive Circuit :	Two-phase bipolar, chopper current regulated.
Bus Voltage :	65 Volt nominal at 120 Volt AC Input.

Rated Current

Full Step :	5.0 Nominal
Microstep :	3.5 Nominal
Micro step with current boost on above 500 full steps/sec. :	5.0 Nominal

ICR Feature	:	Idle Current Reduction circuit reduces motor current 50% during motor idle periods. ICR starts one second after last step input pulse prior to motor standstill. The current is automatically returned to rated value at the next step pulse.
Chopper Frequency	:	20 kHz, nominal
Microstep Current Boost	:	With current boost enabled, driver microstep current is boosted 1.4 times rated microstepping current at step rates above 500 full steps per second. With current boost disabled, driver supplies rated microstep current at all step rates.
Driver State Generator Transition Delay Relative To Input Step:		(1) With stability control circuit enabled, at pulse frequencies less than 500 full steps per second, delay is less than 500 usec. At frequencies greater than 500 full steps per second, delay is less than 270 Degrees of the input pulse period. (2) With stability control circuit disabled, delay is less than 10 usec at all step frequencies.
Stability Control Selection:		With stability control enabled the drive will electronically compensate for mid-range instability which results in loss of torque at higher speeds. Stability control can be disabled via circuit board solderless jumper.
Disable LED Indication:		DS1 LED illuminates for internal driver disable conditions (overcurrent, overtemperature, invalid DIP switch setting on the drive).

2.3 Environmental

This unit is of an "open frame" design and is intended to be placed within a cabinet. The cabinet should be ventilated by filtered or conditioned air to prevent the accumulation of dust and dirt on the units electronic components. The air should also be free of corrosive or electrically conductive containments.

The unit is cooled by natural convection. To ensure proper cooling maintain the spacing recommendations outlined in section 2.7. Also sufficient airflow must be maintained to keep the cabinets internal ambient temperature within the units ratings given the power dissipation estimates in section 2.6.

Operating Temperature	:	0 to 50 degrees C at full rated current 0 to 60 degrees C at 70% full rated current (Microstep mode) with Idle Current Reduction enabled. When mounted as specified in section 2.7.
Storage Temperature	:	-25 to 85 degrees C
Humidity	:	0 to 95%, non-condensing
Altitude	:	1500 Meters (5000 feet)

2.4 Mechanical

Figure 2.1 shows the mechanical outline of the 5440. Three slots are provided for mounting the unit on a vertical surface. The unit must be mounted vertically to ensure proper cooling. The unit weight is approximately 18 pounds and should be mounted accordingly. Recommended mounting hardware are 1/4-20 bolts.

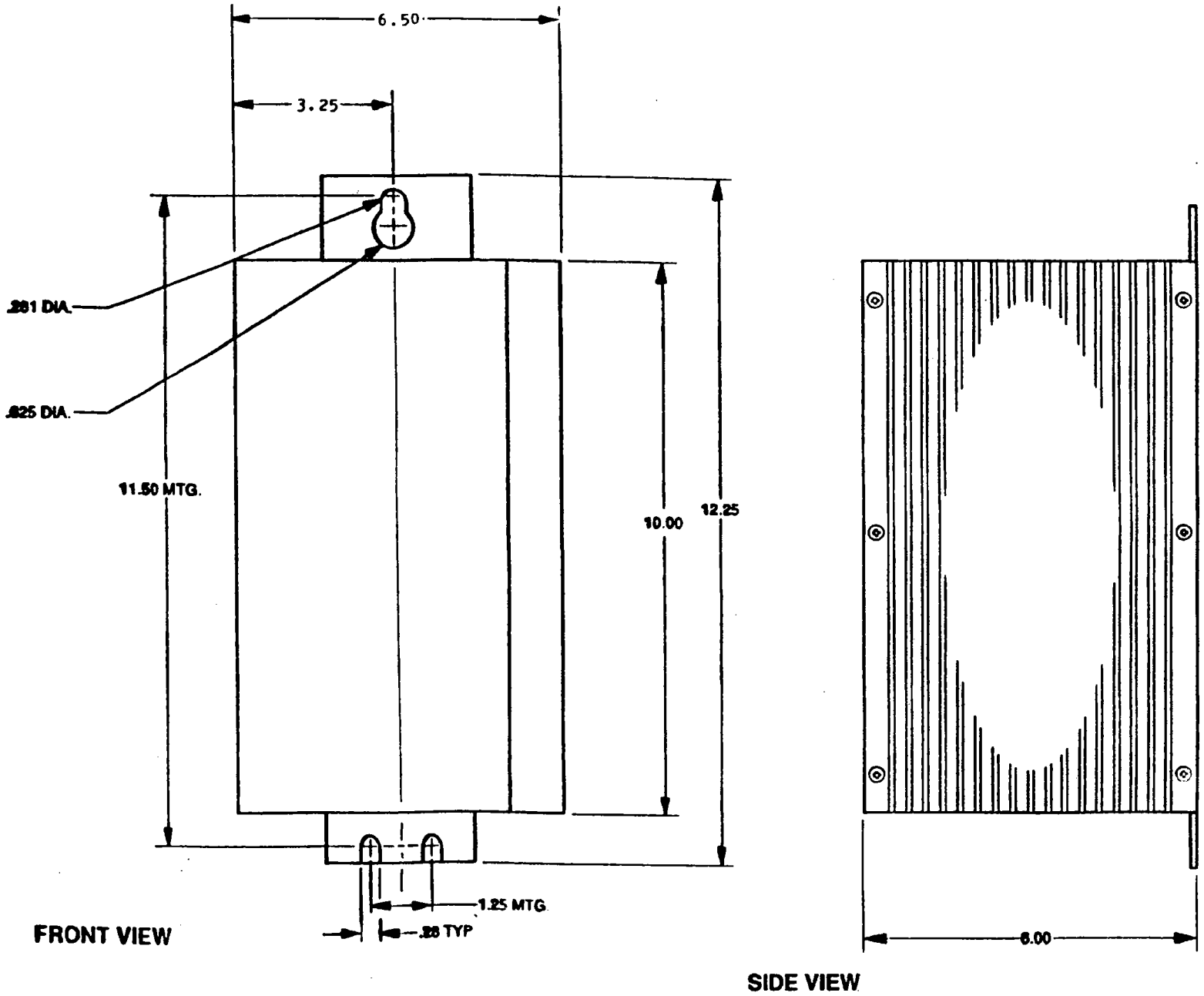


Figure 2.1

Mechanical Outline

2.5 Connector Data

J1 : Parallel Interface
15 pin D-Type, Male

J2 : RS232 Interface
25 pin D-Type, Female

J3 : Internal Connector

J4 : I/O Interface
25 pin D-Type, Male

J5 : Motor Interface
5 pin plug-in screw terminal connector. Mating connector is supplied

J6 : 120 VAC Interface
3 pin plug-in screw terminal connector. Mating connector is supplied

2.6 Power Dissipation

The power dissipation of the 5440 is determined by a number of factors such as motor winding impedance, input step rates, idle current reduction usage , line voltage, ect. For estimating the power dissipation for determining cabinet cooling requirements a number of 40 watts should be used.

2.7 Mounting

Figure 2.1 shows the mechanical outline of the 5440. Mounting is accomplished by three slots located on the unit. The unit must be mounted vertically on a flat, solid surface taking into account its weight of approximately 18 pounds. Recommended mounting hardware are 1/4-20 bolts.

The unit should not be subjected to excessive vibration or shock. The environment should be free of corrosives, moisture, and dust. Refer to Section 2.3 for the environmental specifications of the 5440. To insure proper cooling, there must be a minimum unobstructed space of 4 inches above and below the unit and 1 inch on each side.

Since this unit is of an "open frame" construction, it should be located within an enclosure to protect it from physical or environmental damage. The unit will fit in a standard 8 inch deep NEMA enclosure for industrial applications.

SECTION 3

INPUT SIGNAL CONNECTIONS

There are three connectors located on the side and two connectors on the front of the unit through which all connections are made to the 5440.

J1 : Parallel Interface
J2 : RS232 Serial Interface
J3 : Internal Connector
J4 : I/O Interface
J5 : Motor Interface
J6 : 120 VAC Power Connector

3.1 J1 Parallel Interface Connector

Pin. No.	Signal Name	Source	Function	Interface Circuit
1	Data 1 input	User	1st SB of ASCII character	Fig. 3.1A
2	Data 2 input	User	2nd SB of ASCII character	Fig. 3.1A
3	Data 3 input	User	3rd SB of ASCII character	Fig. 3.1A
4	Data 4 input	User	4th SB of ASCII character	Fig. 3.1A
5	Data 5 input	User	5th SB of ASCII character	Fig. 3.1A
6	Data 6 input	User	6th SB of ASCII character	Fig. 3.1A
7	Data $\overline{\text{Valid}}$	User	A low indicates that seven data input lines are valid.	Fig. 3.1B
8	Ground	Indexer	Logic ground.	
9	+5 Vdc	Indexer	Logic power: 50 mA max.	
10	I $\overline{\text{Run}}$	Indexer	A low indicates that the Indexer is active.	Fig. 3.3
11	$\overline{\text{Acknowledge}}$	Indexer	A 500 us or 50 ms pulse low (selectable by W5) indicates that a character has been accepted; a continuous low indicates an error in transmission.	Fig. 3.3
12	Not used			
13	Data 7 input	User	7th (MSB) of ASCII character	Fig. 3.1A
14	Not used			
15	Not used			

3.2 J2 RS232 Interface Connector

J2 is a 25 pin D-Type, female connector.

Pin No.	Signal Name	Source	Function	Interface Circuit
2	Transmit data(TX)	Indexer	Standard RS 232 output, ASCII coded character.	Fig. 3.1D
3	Received data(RX)	User	Standard RS 232 input, ASCII coded character.	Fig. 3.1C
4	RTS	Indexer	Request to send. Not active. Internal pull up to +9V.	
7	Ground	Indexer	Signal ground.	
9	+5V	Echo Indexer	+5V input opto supply. To be used with J2-10 only.	
10	Serial Repeat input (Rx2)	Echo Indexer	This is a non-standard serial input which is provided to allow optical isolation in daisy chaining of indexers.	
11	$\overline{\text{ACK}}$	Indexer	A 500 usec or 50mS pulse low indicates that a character has been accepted. A continuous low indicates an error in transmission	Fig. 3.3
18	+5V	Indexer	+5V.	
19	I $\overline{\text{Run}}$	Indexer	A low indicates that the Indexer is busy executing.	Fig. 3.3
20	DTR	Indexer	Data Terminal Ready. Not active, internal pull up to +9V.	
25	SCLK	Indexer	TTL, Serial clock, Baud rate x16.	Fig. 3.3

All pins not specified are not used.

3.3 J4 I/O Interface Connector

J4 is a 25 pin D-Type, male connector

Pin No.	Signal Name	Source	Function	Interface Circuit
1	GND	Indexer	Signal ground	
2	GND	Indexer	Signal ground	
3	Remote $\overline{\text{Start}}$	User	This line when pulsed low for at least 2 ms will start the Indexer. This is equivalent to either "G" or "RUN" command, depending on W4 setting (Table 2-5)	Fig. 3.2
4	Remote $\overline{\text{Stop}}$	User	This line when pulsed low for at least 2ms will cause the motor to ramp down and stop if in the immediate mode, or end program if in the program mode.	Fig. 3.2
5	M $\overline{\text{Run}}$	Indexer	TTL; a low indicates that the Indexer is sending pulses to the motor driver.	Fig. 3.3
6	$\overline{\text{Ack}}$	Indexer	TTL, a 500 us or 50 ms pulse low indicates that a valid character has been received. A continuous low indicates an error in transmission.	Fig 3.3
7	I $\overline{\text{Run}}$	Indexer	TTL, A low indicates that the Indexer is active.	Fig. 3.3
8	Serial Repeat (TX2)	Indexer	TTL, ASCII-coded, serial repeat signal, logic levels are inverted from standard RS 232. This line when linked to a secondary Indexer (J2-10) will allow daisy-chained communication; also provide isolation between indexers.	Fig. 3.3
9	+5V I/O	Indexer	Connected to +5V of Indexer card. Can be used as +5V input or output.	
10	+5V I/O	Indexer	Same as pin 9	

11	Spare			
12	Spare			
13	$\overline{\text{Home}}$ Sensor input	User	Normally ignored by the Indexer unless "H+ or H-" command is entered. A logic low informs the Indexer that the home position is detected.	Fig. 3.2
14	K1	User	Programmable input #1. Internally pulled up to +5V. This line can be read only in program to allow conditional branching.	Fig. 3.2
15	K2	User	Programmable input #2. Same As K1	Fig. 3.2
16	K3	User	Programmable input #3. Same as K1	Fig. 3.2
17	K4	User	Programmable input #4. Same as K1	Fig. 3.2
18	K5	User	Programmable input #5. Same as K1	Fig. 3.2
19	$\overline{\text{JOG}}$ +	User	This line when pulsed low for at lease 2 mS will command the Indexer to output a pulse in + direction. When it is held low for more than .5 sec., the output pulse train will switch to start/stop rate until this line is high.	Fig. 3.2
20	$\overline{\text{JOG}}$ -	User	Same as Jog + except the direction is -.	Fig. 3.2
21	Y1	Indexer	TTL, General programmable output #1.	Fig. 3.3
22	Y2	Indexer	TTL, General programmable output #2.	Fig. 3.3
23	Y3	Indexer	TTL, General programmable output #3.	Fig. 3.3
24	Y4	Indexer	TTL, General programmable output #4.	Fig. 3.3
25	Y5	Indexer	TTL, General programmable output #5.	Fig. 3.3

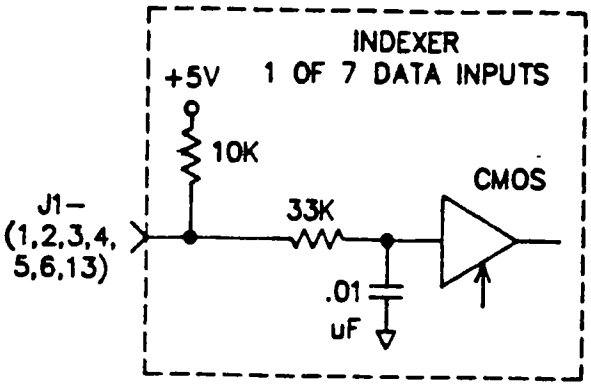


Fig. 3.1A

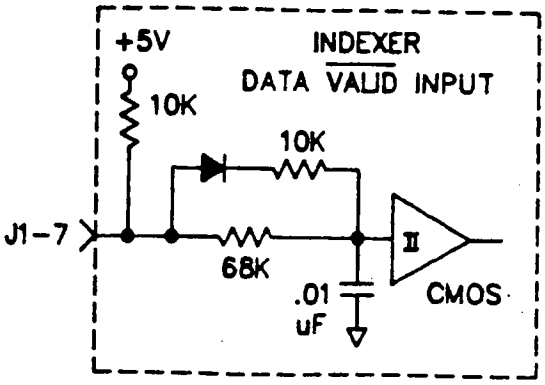


Fig. 3.1B

HIGH = +3.5V TO +30VDC
LOW = 0V TO +1.0VDC
USER'S DRIVEN DEVICE CAN BE TTL OR OPEN COLLECTOR

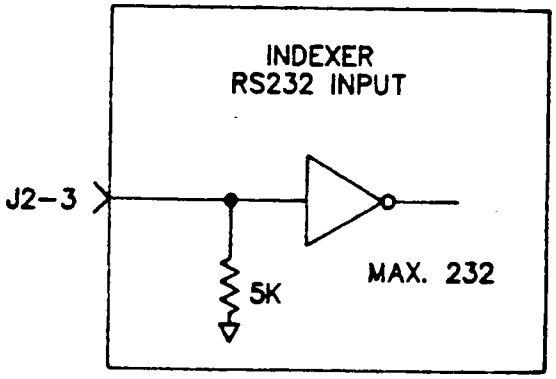


Fig. 3.1C

INPUT VOLTAGE: ± 30V MAX.

LOW: ≤ 0.8 VDC
HIGH: ≥ 2.0 VDC

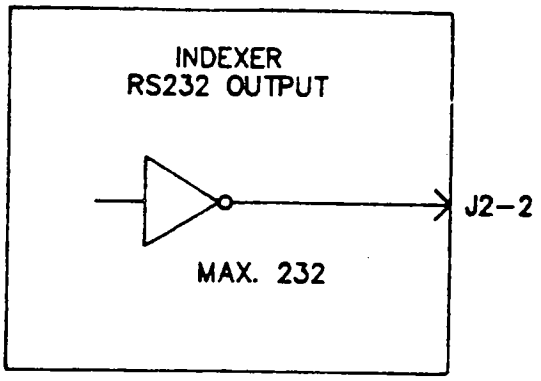


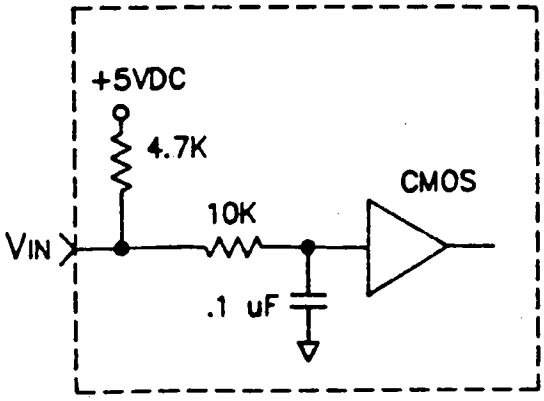
Fig. 3.1.D

OUTPUT VOLTAGE:

±5V TO ±10V
@ 3 KΩ LOAD

Figure 3.1

Serial and Parallel Interface Circuits

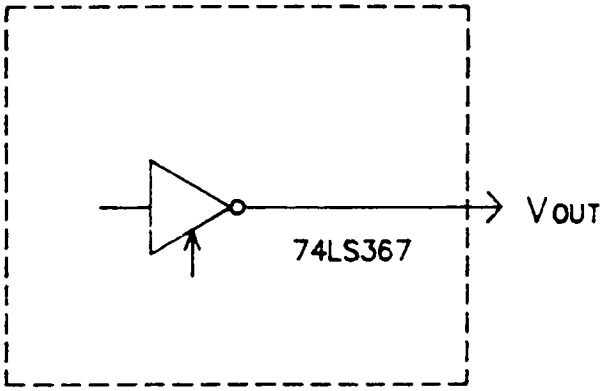


INPUT VOLTAGE:

LOGIC HIGH = +3.5VDC TO +30VDC
LOGIC LOW = 0 TO +1.0VDC
INPUT V_{IN} SHOULD BE STABLE FOR MINIMUM OF 2 MILLISECONDS.

Figure 3.2

I/O Interface Input Circuits



OUTPUT VOLTAGE:

LOGIC LOW = 0 TO +0.8VDC @ 20mA
LOGIC HIGH = +2.4 TO +3.5VDC @ 2mA

Figure 3.3

Output Circuit

3.4 J5 Motor Interface Connector

J5 is a five position plug-in screw terminal connector, mating connector is supplied.

J5 - 1 : Motor phase A connection.

J5 - 2 : Motor phase A/ connection.

J5 - 3 : Motor phase B connection.

J5 - 4 : Motor phase B/ connection.

J5 - 5 : Motor power return. The motor case can be connected to this point to reduce system electrical noise.

Refer to figures 3.4 and 3.5 for typical motor connections for Pacific Scientific bipolar stepping motors.

3.5 J6 120 VAC Power Connector

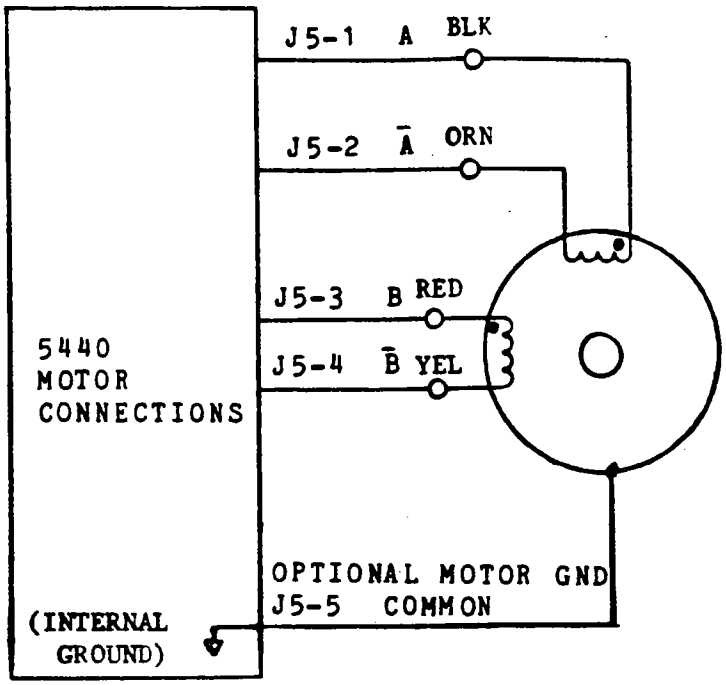
J6 is a 3 position plug-in screw terminal connector, mating connector is supplied.

J6 - 1 : Chassis ground point. This terminal is the safety ground point for the unit and must be tied to earth ground to prevent shock hazard.

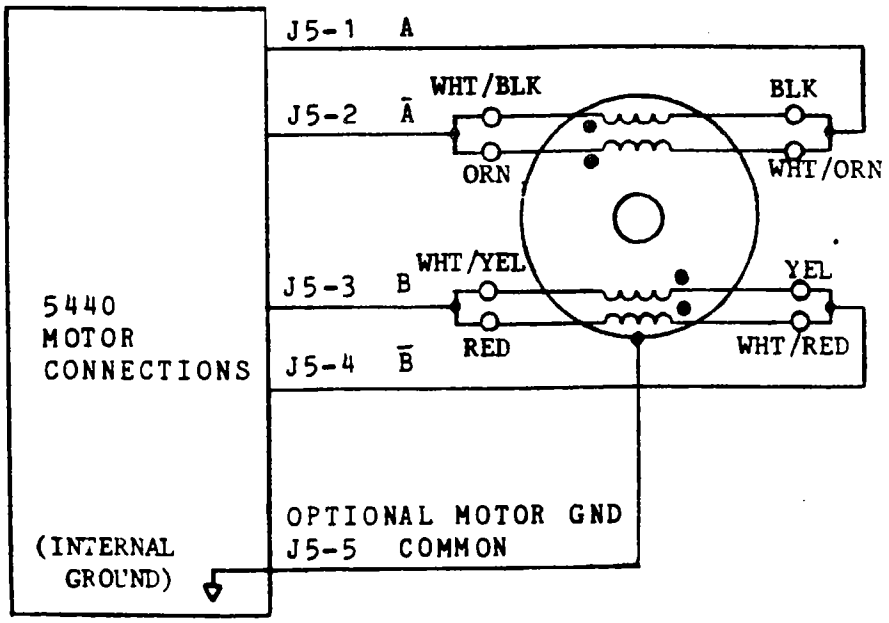
J6 - 2 : 120 VAC input.

J6 - 3 : 120 VAC input.

No special phasing of the 120 VAC inputs is required.



4 LEAD MOTOR



8 LEAD MOTOR

Figure 3.4

Standard Motor Connections For Sigma Line Motors

5440 MOTOR CONNECTIONS	SIGMA MOTOR TERMINAL BLOCK		
	4-INCH DIAMETER SPLASHPROOF		3-INCH DIA. SPLASHPROOF
	4 Lead	8 Lead	4 Lead
J5-1 A	1	1	2
J5-1 A		5	
J5-2 $\overline{A}$	3	3	3
J5-2 $\overline{A}$		6	
J5-3 B	2	2	1
J5-3 B		7	
J5-4 $\overline{B}$	4	4	4
J5-4 $\overline{B}$		8	

Figure 3.5

Motor Connections For Splash Proof Motor Terminal Blocks

SECTION 4

JUMPER AND SWITCH SELECTABLE FUNCTIONS

The function selection jumpers and dip switches are located on both the indexer and the driver. The indexer selections are accessed by removing the side cover which is held in place by four screws. The driver selections are accessed through the bottom opening of the package. Refer to figures 4.1 and 4.2.

The switch functions on the indexer are read only on power up, therefore it is necessary to recycle power after making changes.

IMPORTANT: DUE TO THE PRESENCE OF HIGH VOLTAGES WITHIN THE 5440 PACKAGE, JUMPER AND SWITCH ADJUSTMENTS SHOULD ONLY BE DONE WITH POWER OFF.

4.1 Communications Interface Functions

The communications interface jumpers are located on the indexer Printed Circuit board. Refer to figure 4.1.

Baud Rate : The baud rate is selected by Jumpers W1 and W2 as shown in Figure 4.3.

	JUMPER POSITION				
	W1		W2		
Baud Rate	BLO	BHI	AA'	BB'	CC'
300	X	-	X	-	-
600	X	-	-	X	-
1200	X	-	-	-	X
2400	-	X	X	-	-
4800	-	X	-	X	-
9600	-	X	-	-	X

NOTE :
X = Selected

Figure 4.3

Baud Rate Selection Jumpers

Echo-Back : Echo back of the received data on the serial link is enabled by W7.

W7 POSITION	ECHO
F-E	IN
F-D	OUT

Acknowledge : The acknowledge output is a TTL level output which is available on J1-11, J2-11 and J4-6. This output goes to a logic low state whenever an ASCII character is received over the serial or parallel interfaces. Jumper W5 sets the duration of the output pulse.

W5 POSITION	ACKNOWLEDGE PULSE WIDTH
A-F	500 microseconds
A-S	50 milliseconds

4.2 Microstep Size Selection

The step size of the motor is dip switch selectable via dip switches on both the indexer and the driver. Both sets of switches should be set as shown in Fig. 4.4.

MOTOR STEP SIZE	INDEXER SWITCH SETTING S1-1	S1-2	S1-3	DRIVER SWITCH SETTING SW1-1	SW1-2	SW1-3
Full	0	0	0	0	0	0
1/2	0	0	1	1	0	1
1/5	0	1	0	1	0	0
1/25	1	0	0	0	1	0
1/125	1	0	0	0	0	1

NOTE: 1 = OPEN, 0 = CLOSED

Figure 4.4

Microstep Size Switch Settings

MOTOR STEP SIZE	STEPS/REV	MAXIMUM COMMAND VELOCITY (STEPS/SEC)	OUTPUT PULSE RATE MULTIPLIER	MAXIMUM OUTPUT PULSE RATE (PULSE/SEC)
Full	200	20,000	1	20,000
1/2	400	20,000	2	40,000
1/5	1,000	20,000	5	100,000
1/25	5,000	10,000	25	250,000
1/125	25,000	10,000	25	250,000

Figure 4.5

Maximum Microstep Velocity Table

of the step size for all microstep modes except for 1/125 microstep. In 1/125 microstep mode the multiplier is 25. Figure 4.5 shows the maximum velocity command (limited by the indexer), the rate multiplier and the maximum run frequency of the indexer. It is important to note that the distance command does not use a multiplier. If a distance of 1000 (D1000) is set in 1/25 microstep mode, the motor will be commanded to move 1000 1/25 microsteps, a full step distance of 40 full steps.

4.3 Device Identification Code

Up to eight 5440's may be operated off of a single RS232 serial link. This is accomplished by setting a unique identification code for each unit via indexer dip switch S1 positions 4, 5 and 6 as shown in Fig. 4.6. Refer to section 6.3 for detailed operation information.

Identification Code	S1 Indexer Switch 1	2	3	4	5	6
0	X	X	X	0	0	0
1	X	X	X	0	0	1
2	X	X	X	0	1	0
3	X	X	X	0	1	1
4	X	X	X	1	0	0
5	X	X	X	1	0	1
6	X	X	X	1	1	0
7	X	X	X	1	1	1

NOTE: 1 = OPEN, 0 = CLOSE, X = OPEN OR CLOSED

Figure 4.6

Unit Identification Code Table

4.4 Indexer Configuration Jumpers

Jumpers W3 and W6 located on the indexer are configuration jumpers and should be left in the following positions.

JUMPER	POSITION
W3	J-H
W6	INT

4.5 Remote Start Switch Mode

The remote start switch can be used to either initiate a G (go) command and run an immediate mode index or be set to initiate a RUN command and start a stored program from memory. Jumper W4 sets this option. Refer to section 5 for more details on immediate and program mode of operation.

W4 POSITION	REMOTE SWITCH MODE
J-H	RUN (Program Mode)
J-L	IMMEDIATE (Go)

4.6 Idle Current Reduction (ICR)

Idle Current Reduction Enable/Disable dip switch is located on the driver. Enabling or disabling the ICR circuit is accomplished by means of Dip Switch SW1 Position 6. When enabled Idle Current Reduction will reduce phase current flowing to both motor windings to one-half the nominal value after not receiving a step input pulse for approximately one second. Current will remain at this reduced level until a step pulse is received by the drive. At this time phase current(s) will return to their previously set values and stepping will occur.

Current reduction is useful to conserve energy at standstill or to allow the motor to cool in high duty cycle applications. It should be noted that the holding torque generated by the motor will also be reduced by approximately 50% when ICR is enabled.

Dip Switch Position 6	FUNCTION
Open	ICR ENABLED
Closed	ICR DISABLED

4.7 Mid-Range Stability Control

Mid-Range Stability Control circuit is Enabled or Disabled by dip switch SW1 position 5 located on the drive.

With stability control circuit enabled, the step input timing is modified to control and maintain synchronous motor speed in the midrange instability region of the stepping motor system's torque vs speed curve. At pulse frequencies less than 500 full steps per second, delay is less than 500 usec. At frequencies greater than 500 full steps per second, delay is less than 270 Degrees of the input pulse period. When disabled, the stability control circuit has no effect on input pulse timing.

DIP SWITCH POSITION 5	FUNCTION
OPEN	STABILITY CONTROL ENABLED
CLOSED	STABILITY CONTROL DISABLED

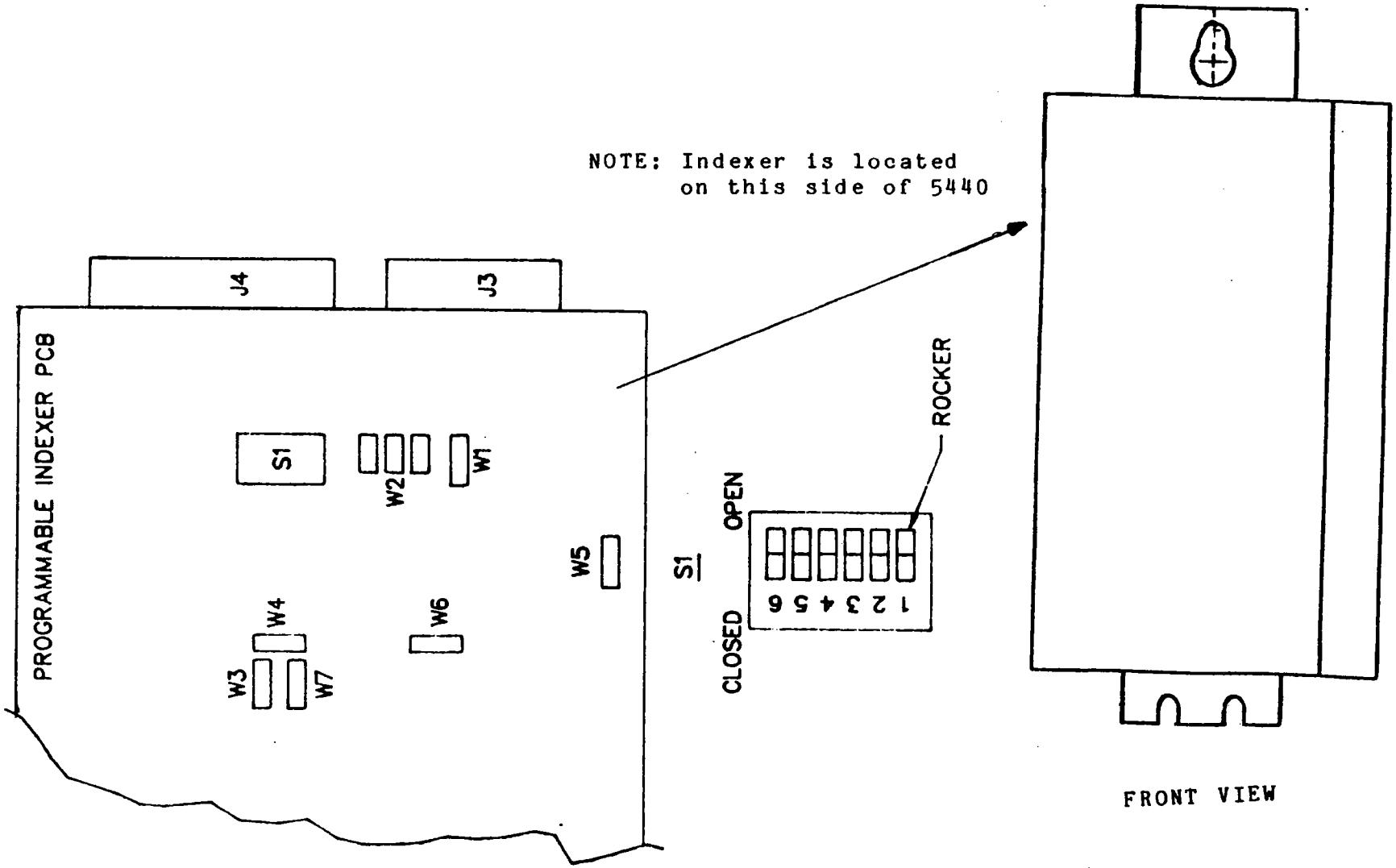
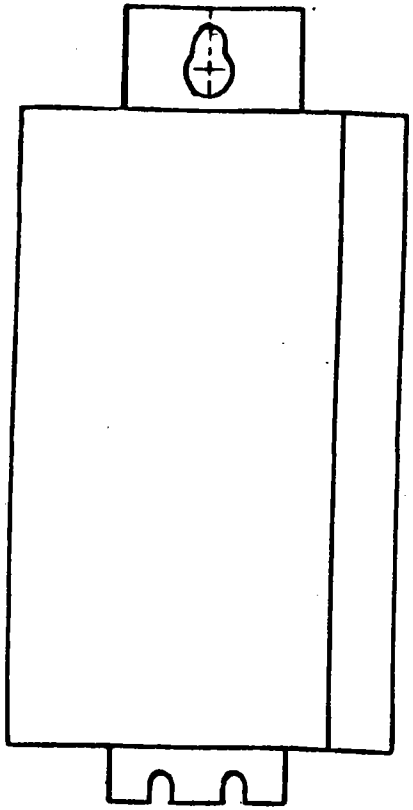
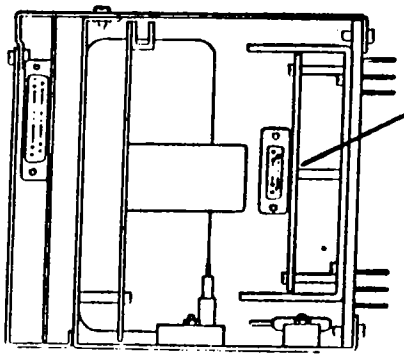


Figure 4.1

Jumper and Switch Locations on Indexer



FRONT VIEW



BOTTOM VIEW

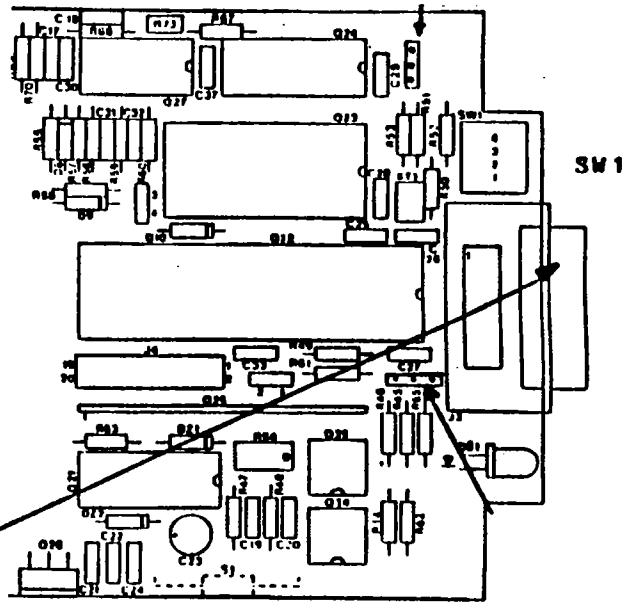


Figure 4.2

Jumper and Switch Locations on Driver

SECTION 5

PROGRAMMING

The indexer can be programmed and controlled using standard 7-bit ASCII characters transmitted to either the serial RS232C port (J2) or the parallel port (J1). The use of standard ASCII command codes allows conventional personal computers and terminals to be used to program or control the indexer using the serial port.

The indexer can operate in either the Immediate or the Program mode.

Immediate Mode:
In the Immediate mode, a command will be executed as soon as the appropriate string of ASCII characters is received. For example, if the indexer is not busy executing a program or in the middle of a move, motion will begin as soon as "G" of the following string is received[1]:

```
+ F300 V2000 T.2 I D5000 G
```

The resulting move will have the following characteristics:

Direction: positive	+
Start speed: 300 full steps/sec	F300
Maximum velocity: 2000 full steps/sec	V2000
Accel/Decel time: 0.2 sec	T.2
Move type or mode: Index	I
Move distance: 5000 steps (of chosen step size)	D5000

The same motion will be repeated if another "G" character is received by the indexer.

The index distance can be changed to 6000 steps and a move initiated (having all the properties of the above move except for the index distance) by sending the following string to the indexer:

```
D6000 G
```

That is, the motion parameters are stored in the indexer and remain in effect until different values are received via the serial or parallel data links.

The Immediate mode is often used during system setup and test. It might also be used when a computer is used as the "high level controller" in a system.

---

1. A detailed description of all indexer instructions is given in Section 5.1.

Program Mode

In the Program mode, a sequence of commands that have been stored in the indexer's memory are executed. Commands are entered using the indexer's edit mode. The indexer goes into the edit mode when the following string is received:

E <Return>.

The simple program, described below, can be entered by sending the following characters to the indexer (after entering the edit mode):

```
B1 + F300 V2000 T.2 I<Return>
B2 J3(K1 = 1) J4<Return>
B3 D5000 G W2 J2<Return>
B4 D10000 G W1 J2<Return>
B5 END<Return>
<ESC>
```

Each program line must start with a "block number", Bxx, where xx is a number between 1 and 40. Block numbers are similar to line numbers in the BASIC computer language. For example, they are used in jump instructions to identify the jump destination.

The indexer exits the edit mode when the escape character <ESC> (ASCII Code 27) is received. The five program "blocks" shown above are stored in the indexer's memory[1] after exiting the edit mode.

The five-line program can be executed, after exiting the edit mode, either by sending the string "RUN" (or "RUN 1") to the indexer over the serial or parallel data link or by pulsing the Remote Start/ input (J4 pin 3). The program causes an endless sequence of indexed moves to be made. The moves will be 5000 steps separated by a 2 second dwell if Programmable Input 1 is high but 10,000 steps separated by a 1 second dwell if Programmable Input 1 is low. The cycle can be changed from one type to the other at any time by toggling Programmable Input 1. Program execution can be terminated at any time by sending "S" to the indexer over the serial or parallel data links or by pulsing the Remote Stop/ input (J4 pin 4).

---

1 The program is stored in the indexer's volatile memory (RAM) after exiting the edit mode. The program will be lost if power is removed from the 5440 and any program stored in non-volatile memory will be restored. To store a program in non-volatile memory, a Program Store (PS) command must be given (See Section 5.1).

Operation of the 5 program blocks is as follows:

B1 sets up the following parameters for all motion in this program:

Direction: Pos	+
Start Speed: 300 full steps/sec	F300
Max Speed: 2000 full steps/sec	V2000
Accel/Decel time: 0.2 sec	T.2
Move type: Index	I

B2 is an example of the conditional jump statement. Programmable Input 1 is sampled and if high then control is transferred to Block 3 {J3(K1 = 1)}. If Programmable input 1 is low, then the next command after J3(K1 = 1) is executed (J4) which transfers control to Block 4.

B3 initiates an indexed move of 5000 steps (D5000 G). After the move is accomplished, a dwell of 2 seconds occurs (W2) and control is transferred back to Block 2 (J2).

B4 initiates an indexed move of 10,000 steps (D10000 G). After the move is accomplished, a dwell of 1 second occurs (W1) and control is transferred back to Block 2 (J2)

B5 is an END statement which should be at the end of every program. In this example the END is never executed but an END command will terminate program execution and return the indexer to the Immediate mode.

5.1 Command Description

A description of the command set is given below. I, P, or IP to the right of each command indicates whether it can be used in the Immediate, Program or either mode. A tabulation of the commands is given is Section 10 which is a useful memory aid when programming. It is recommended that the examples at the end of Section 5 be referred to often to aid in understanding the application of the commands.

NOTE

x and z indicate the maximum numerical digits that could appear in the command. Leading zeros are not required. <cr> denotes a carriage return, <cr> is only required for specific immediate commands.

All Clear AC <cr> I

Clears user program in RAM and re-initializes the indexer to the power-up state. Non-volatile memory is not cleared unless the Program Store (PS) command is used.

Block Program Number Bxx P
A Block Program number must start each program line. xx is a one or two digit number from 1 to 40. A block may contain a single command character or multiple move parameters up to 250 characters long. Block numbers must be written in order but not necessarily consecutively.

Move Cycle Count Value Cxxxxx I, P
Sets the Move-Cycle-Count which causes the next move command to be executed the specified number of times. xxxxx is a one to five digit numbers from 0 to 65535. C0 or C1 are both interpreted as a single move. Note that the C command will only repeat the same single move. For repeating different multiple moves, see the Jump Unconditional and Jump Conditional commands (Jxx and Jxx(K=zz)).

Global Current Control CCx I, P
Sets driver current to full (x = 1) or zero (x = 0).

Cycle Stop CS I, P
Stops motion after current motion profile is completed and exits program if it is executing.

Distance Value Dxxxxxxx or + xxxxxxx I, P
Sets the distance parameter which specifies the exact number of pulses that will be output from the indexer in any step size settings (i.e. the distance parameter specifies the move distance in microsteps). xx is a one to seven digit numbers from 1 to 9,999,999. If the direction is given, D can be omitted. Example: +D12345 and +12345 are the same.

Edit E <cr> I
Enables the user to write a series of numbered program blocks continuously into ram. If the Program is not blank, it will be listed and all entered characters will be written into the next consecutive memory locations. To exit editing mode, the ESC character (ASC27) or # character are used.

Edit Block Exx <cr> I
Is used to enter or edit a single program block. Exx returns the user's program block specified by xx for modification or deletion. The entire block must be re-entered completely. To delete a block, simply type Exx followed by <Enter>. To exit the single block editing mode the ESC character or # character are used.

End Program END P
Terminates execution of the stored program and returns the indexer to the Immediate mode.

Start/Stop Velocity Value Fxxx I, P
Sets the start/stop velocity in full steps per second. xx is a two or three digit numbers between 25 and 999 which will be rounded to the nearest 25 full steps/second. The actual output pulse rate is xx (rounded) multiplied by the microstep factor (1, 2, 5, or 25) set by S1.

DEFAULT

If a start/stop velocity command has exceeded the maximum allowable value then it defaults to no change.

Go Command G I, P
Initiates a move immediately if the indexer is not active (not executing a program and not in the middle of a move). When used in program blocks, G will initiate a move. Except for run-at-velocity moves (R mode), the indexer will stop reading program character until the move is completed. When running-at-velocity, the program will continue to be read. This allows the velocity to be changed using the discrete inputs (See program examples).

Go with Trigger Events G (trigger input output, P
trigger input output...)

Starts motion but can interrupt the move as described below:

Trigger Inputs: 1 of 3 triggered sources can be used:

Nxxxxxx:	Full step values. Always counted from the beginning of a move. (I or R move)
Wxx.xxx:	Wait time delay. Start timer, when top velocity is reached. (not available during index move).
Kx = x:	Sample input K until it is true. (I or R move)

Outputs: 1 of 3:

Yx = x:	Available in both index or run moves.
Vxxxxx:	Run move only.
S:	Run move only.

Format: G (input output, input output....)
Input output must be in pair, each pair must be separated by comma. The whole string of input outputs must be in the parenthesis following a G. If velocity changes are commanded, the velocity ramp slope is established by the first ramp slope in the string.

Home Electrical Return Command HE I, P
Initiates a move to Electrical Home. (See the description for the Mechanical-Home-Search commands for a definition of Electrical Home.) The velocity and ramp time used in the move may be specified prior to HE command. Otherwise, the last parameters entered for V and T will be used. For Pos. >9,999,999 2 moves are used.

Mechanical Home Search Command H+ I, P
Initiates a move at start/stop velocity in the positive direction until the home sensor input becomes active (indicating near home). Motion is reversed and the motor is run at the start/stop velocity until the home sensor becomes inactive. The motor is then stepped in the positive direction at 10 full steps per second until the home switch becomes active. This position is defined as Mechanical Home. The search algorithm just described minimizes hysteresis and overshoot errors in Mechanical Home as described after the H- command is introduced.

If the Position Offset default parameter is non-zero (See Section 5.2 for directions on setting the default parameters), the motor will be rotated to the Electrical Home position which is offset from Mechanical Home by the Position Offset value. Motion will stop at Electrical Home and the Position Counter will be set to zero.

Mechanical Home Search Command H- I, P
Initiates a move at start/stop velocity in the negative direction until the home sensor input becomes active. Motion is continued in the negative direction until the sensor becomes inactive. The motor is then stepped in the positive direction at 10 full steps per second until the home switch becomes active.

Note that both the H+ and H- command make the final move to the home switch in the same direction and at the same speed. This minimizes hysteresis and overshoot errors.

If the Position Offset default parameter is non-zero, the motor will be rotated to the Electrical Home position and the position counter set to zero.

Home Mechanical Return Command HM I, P
Initiates a move at the Run velocity towards, but slightly short of, the "known" Mechanical Home position. The remainder of the move will utilize the H+ or H- search algorithm depending upon the direction of motion. The HM command gives shorter search times when the Mechanical Home position is known approximately since the initial move is made at the Run speed instead of the Start/Stop speed.

Index Move I I, P
Outputs exact number of pulses specified by the D command when the next Go (G) command is processed. The indexed move will use the ramped velocity profile.

Jump Block Unconditional Jxx P
Jumps forward or backward in the user's program to any valid block number from 1 to 40 including the current block.

Jump Block Conditional Jxx (K=zz) or Jxx (Kx=z) P
Tests the state of programmable input(s). Program control transfers to block number xx if the specified input condition is satisfied otherwise the next instruction is executed. The inputs can be tested globally (K = zz) or individually (Kx = z) depending upon the program requirements. The relationship between the global parameter zz and the programmable inputs is given in Figure 5.1.

Jump Block Counter Jxx (n) P
Jumps to block xx n times. n can be any number from 1 to 65535. Block xx is executed n + 1 times.

Note: Nesting of Jxx(n) instructions is not allowed. It is not valid to include a Jxx(n) instruction in a block (or group of blocks) that is entered using a Jxx(n) instruction.

Figure 5.1
I/O (K and Y Global Command Bit Codes)

Commanded Decimal Value (zz)	STATE OF K5/Y5	K4/Y4	K3/Y3	K2/Y2	K1/Y1
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0
31	1	1	1	1	1

0 = Logic Low (0 - 0.8V)
1 = Logic High (2.4 - 5.0V)

List L <cr> I
Transmits (returns) user's source program over serial communications port.

List Block Lxx <cr> I
Returns only block number xx.

Line Feed LFx <cr> I
Sets or clears the line feed flag. The indexer will automatically generate a line feed after receiving a carriage return <cr> if the line feed flag is set (LF1) otherwise (LF0) a line feed character is not generated.

Number of full step pulses Nxxxxxx P
Sets trigger point for Go-With-Trigger-Events command. Nxxxxxx is an even number from 2 to 131,072 which is counted from the beginning of a move. This could be a point where the velocity is changed (in Run profile) or output bits changed. If an odd value is entered, then the N will be rounded to the next lower even number. If the Nxxxxx is less than the current full step position then the actual N will be Nxxxxxx + 131,072.

Absolute Move P+-xxxxxxxx (+ sign optional) I, P
Moves to an absolute position (absolute position determined by position counter) when the next GO (G) command is processed. The position range is +16,777,200 to -16,777,200.

Program Store PS I
Stores the user's program from RAM to non-volatile memory. After editing, the user's program is not stored in non-volatile memory until the PS command is issued.

Program Recall PR I
Recalls the user's program from non-volatile memory to RAM. The PR and PS commands are provided to allow the user to modify the program in RAM as scratch pad until a permanent program stored is desired. The contents of non-volatile memory is automatically recalled at power up.

Query, (Status & Parameter Request) Q <cr> I
Returns indexer ID, internal status, operating parameter, position counter and I/O states.

Query (parameter request) QP I
Returns all operating parameters.

Query (status request) QS I
Returns ID address, micro step size, status byte, position value and Input/Output states.

Ramp Velocity Move R I, P
Ramps up to the velocity value when a Go (G) command is processed. In the Immediate mode, the velocity can be changed at any time by entering a new velocity (Vxxxxx). In the Program mode, the indexer continues to process instructions after a Ramp Velocity Move has been initiated by a Go command. This allows the velocity to be controlled using the programmable inputs as shown in the examples.

IMPORTANT NOTE: When velocity is changed "on the fly" in the Program mode, the Vxxxxx command must be followed immediately by G. The following example illustrates a valid program which lets Programmable Input 1 control the step rate:

```
B1  + F200 T.1 R
B2  J3(Y1 = 1) J4
B3  V2000 G J2
B4  V4000 G J2
B5  END
```

Note that G follows the Vxxxx command in Blocks B3 and B4.

Run Program Run xx <cr> I
Executes program beginning at the block specified by xx. If xx is deleted, program execution begins at the lowest block number. An "END" command in the program will terminate the program mode.

Stop Command S I, P
Initiate ramped deceleration to stop. If the command is used in a program statement, the next command will be executed after stopping. If the command is received over the serial port, parallel port or from the Remote Stop input, program execution is terminated.

Ramp Time Tx.xx I, P
Sets the acceleration/deceleration time (seconds) between the Start/Stop speed and the Run speed. x.xx is a number from .01 to 9.99. If x.xx = 0, the indexer will not ramp above the Start/Stop speed.

Trace TRx <cr> I
Sets the trace flag. With set to one (TR1), the contents of each program block will be listed when that block is entered during program execution. This is a highly useful debugging aid.

Full Step Velocity Value Vxxxxx I, P
Sets the run velocity in full steps per second. xxxxx is a 1 to 5 digit numbers from 25 to 20,000 which will be rounded to the nearest 25 full steps/second. The actual output pulse rate is the commanded velocity multiplied by the micro step factor (1, 2, 5, 25) set by DIP Switch S1.

DEFAULT
If a velocity command is given over the maximum allowed value then it will be set equal to Start/Stop velocity (F).

Wait Time Wxx.xxx I, P
Sets the wait time in seconds. xx.xxx is a number from .001 to 65.535 which represents a wait time in seconds before starting the next move or executing the next program command. This command can be used as a trigger point for velocity changes in the ramped velocity mode, as a dwell time between index or absolute moves, or as a programmable delay for output events. Wait Time also determines the dwell between moves repeated using the Cxxxxx and X commands.

NOTE
The ramp timer and the wait time share the same indexer hardware timer, hence, the wait-timer should not be used when the indexer is ramping motor velocity.

Cycle Continuous X I, P
Causes the next move to be repeated indefinitely until a Stop command is received.

Global Programmable Output Y = xx I, P
Sets all five programmable outputs, Y, to the value specified by xx. xx is a one or two digit number between 0 and 31. The pattern of outputs as a function of xx is shown in Figure 5.1.

Single Programmable Output Yz=x I, P
Sets one general purpose output line Yz (Y1 to Y5) to either logic high or low specified by x (0-1).

Software Reset of Position Counter ZR+xxxxxxx<cr> I, P

Sets the internal position counter to any value from 0 to 9,999,999. Future output pulses are added to or subtracted from the position counter depending on direction.

Delimiter, Indexer Addressing /x I

Selects the indexer with ID set to x (x is a number from 0 to 7) to respond to the message(s) that follows. All indexers with non-matching ID number will ignore commands until the next delimiter is detected. If the delimiter, /, is followed by a non-digit character, the following commands are responded to by all indexers (global commands). Refer to Section 5.3.

NOTES

The indexer will accept lower case letters and convert them to upper case. "<" is a reserved character used by the indexer in report messages only. The messages sent out from the indexer are always pre-fixed by the character "<". This will turn off all other indexers in daisy-chained operation from listening until a <cr> at the end of message.

Scan Inputs Continuously Functions [Format (see below)] P

Sets up a scan function which monitors the programmable inputs continuously and interrupts normal program operation if the specified condition occurs. Once the program is interrupted, a Scan Function will not generate another interrupt until the specified input(s) have changed and then returned to the specified condition (i.e. Holding the inputs in the specified condition will generate one interrupt only.). The scan function is entered as part of the program (as a program block). When the scan command is read, it will remain in effect throughout the program until a new scan command is processed. A maximum of two input scan functions are provided. Four formats are available:

Format 1: [z SKx = x, Y = x]
Format 2: [z SKx = x, Y = x S]
Format 3: [z SKx = x, Y = x S Jxx]
Format 4: [z SK0] (Disables scan function)

NOTES:

z (1-2) Input scan 1 or scan 2
Default: If it is not specified, Scan 1 is used.

SK... defines the input scan condition. It can be single or global.

The Y = x statement is optional in Formats 2 & 3.

Y... specifies the desired state of the discrete outputs. This command can be single or global. The output command will be performed immediately.

If S (stop command) is given but not Jxx, the indexer will ramp down to a stop and EXIT the program. If S Jxx are given, the indexer will ramp down to a stop then jump to specified block number. Default: If Jxx is given without S, the indexer will be forced to stop and exit program (error condition).

5.2 Indexer Power-up Defaults

The indexer fixed defaults are listed below:

Move Profile	R (Ramped Velocity)
Distance	D0
Start/Stop	F25
Velocity	V25
Ramp Time	T1.0
Cycle	C0
Direction	+
Wait Time	W0
Position Counter	ZRO
Line Feed	LF1

The user can select and program the following default functions:

Current Idle	CIx
Current Run	CRx
Current Boost	CBx
Position Offset	PO +xxxxx
Home Sensor True Level	Hx (0-1)
Programmable Outputs	Y = xx

The new default information must be enclosed in square brackets and can only be entered into the indexer after power-up and before the first "GO" (G) command. The specified parameter will automatically be stored into non-volatile memory.

Format: [CIx.xCRx.x CBx.x PO +xxxxx Hx Y = xx]
The order of entry is not important and only parameters that need change must be entered.

5.3 Indexer Addressing

Unique Address Assignment

The indexer can be assigned an identification number from 0 to 7 using DIP switch S1 (Refer to Section 4.3 for switch settings). The address DIP switch is only read during power-up. This will allow a single user programming device (UPD) output module to address and operate multi-axis systems. Data repeat of the index commands is available when using serial or parallel UPD communications (See Section 6.3). To address a specific indexer, the UPD must prefix the standard command codes with the indexer ID number, and enclose the command within delimiters (/).

Examples:

- /2G will start indexer #2.
- /7 D1000 will set the distance for indexer #7 only.
- /3 D2000 T50 V500 F300 + C4 G/ This will set distance, ramp time, final velocity, start/stop, speed, direction, and number of cycles for indexer #3 only.
- /2 V4000 D6000 /4 V3000 D5000/ Indexer with ID #2 will receive V4000 and D6000. Indexer with ID #4 will receiver V3000 and D5000.

Global Address Assignment

Global commands can be sent to all indexers connected to the UPD device, without using an ID prefix. When using only one indexer, these types of commands can be used. If multiple indexers are used, one global command can be sent and all will respond.

Examples:

- /S will stop all indexers.
- / I D500 T.1 V500 G will index all indexers 500 steps at a velocity of 500 steps a second with a ramp up/down time of 100 ms.

5.4 Receiving Input Commands

Input commands from either serial or parallel ports are received continuously under the following conditions:

No Move in Progress (I Run = High)	Move in Progress Immediate (G) Mode (I Run = Low)	Move in Progress Program (RUN) Mode (I Run = Low)
Any valid command is accepted	All commands related to move parameter (D, V, T, +/-, I/R, C) are accepted and stored for the next move (except G). Other commands are immediately processed. If an R move, the V command is updated immediately (velocity change on the fly).	Only Stop, List or Status command Q are accepted. All other commands are ignored.

5.5 Output Status Signals

Three TTL level status outputs indicate the status of the indexer:

The I Run line indicates that a move sequence is in progress, (Motor may or may not be moving, due to delay between moves caused by wait command or scan of inputs.)

The Acknowledge signal indicates that the last transmission on the line was decoded and accepted by the indexer.

The M Run signal indicates that pulses are being sent to the drive.

5.6 Programming Examples

The following four examples are of the immediate mode type:

Cycle Index Move

```
I F300 D5000 V3000 + T1.0 W.25 C2 G
```

Note:
Spaces are not necessary but are recommended (and used in the examples) for clarity. The following line produces identical results as the above: IF300D5000V3000+T1.0W.25C2G

This move profile will start the motor at 300 steps per second (F300) and will index for 5000 steps (D5000) at a peak velocity of 3000 steps-per-second (V3000) in the clockwise direction (+). The ramp up/down time is 1 second (T1.0). It will do this move two times (C2) and stop. The dwell time between moves is .25 seconds. To repeat this move, transmit G.

Absolute Move

```
ZR0 F300 V3000 P4000 G
```

This move profile will reset the position counter to zero (ZR0), then start the motor at 300 steps per second and move to absolute position 4000 (P4000) at a top speed of 3000 pulses per second (V3000). The Query command (Q) can be used to verify that the position counter is at 4000 at the end of this move (POS= +4000).

Velocity Move:

```
R V10000 - T0 G
```

Since T0 is used, this move profile will start the motor at it's start/stop velocity (Fxxx) and will not ramp up/down. It will run at the start/stop velocity until a stop command (S) is received. Rotation will be in the counterclockwise direction (-).

Infinite Cycle Move:

```
I D400 T.5 V500 + W.5 X G
```

This move profile will index (I) the motor 400 steps (D400) at a velocity of 500 steps a second (V500). It will repeat this move with a .5 second dwell an infinite number of times or until a stop command is received.

Single Pulse:

```
I D1 + G
```

This move profile will advance the motor one step in the positive direction (+).

The following examples are of the program mode type:

Velocity Change on Position Count:

```
B1 V2000 T.02 + R G (N2000 V6000, N5000 V4000, N9000 S)
```

See Figure 5.2

Velocity Change & Trigger Events:

```
B1 V4000 T.1 - R G (W1  V6000, W2 Y3 = 1, K1 = 0 V2000, W.5
S)
```

See Figure 5.3

Trigger Outputs on Position Count:

```
B1 ID10000 V1000T.1 G(N3000 Y2 = 1, N6000 Y4=1)
```

See Figure 5.4

Multiple Moves:

```
B1 T.1 F100 V1000 D2000 G W.1 V2000 D5000 C2G
```

See Figure 5.5

Conditional and Unconditional Jumps :

```
B1 I F100 V1000T.1
B5 J10 (K1 = 0) J15
B10 D1000 G W2 J5
B15 D2000 G W1 J5
```

See Figure 5.6

Discrete Speed Control:

```
B2  F100 Y=0 R
B4  J10(K1=0) J12(K2=0) J14(K3=0) J16(K4=0) J4
B10 Y=1 T.1 V4000 G J4
B12 Y=2 T.5 V10000 G J4
B14 Y=4 T4 V20000 G J4
B16 Y=8 S J4
B20 END
```

The motor speed as well as discrete outputs Y1, Y2, Y3 and Y4 are controlled by discrete inputs K1, K2, K3, and K4 as shown in the table below. When a new speed is selected, the ramp time will be determined by the Tx expression preceeding the speed in the corresponding program block.

K1	K2	K3	K4	Motor Speed (Steps/sec)	Y1	Y2	Y3	Y4
0	X	X	X	4,000	HI	LO	LO	LO
1	0	X	X	10,000	LO	HI	LO	LO
1	1	0	X	20,000	LO	LO	HI	LO
1	1	1	0	0	LO	LO	LO	HI
1	1	1	1	NO CHANGE IN MOTOR SPEED OR OUTPUTS				

Advanced Program Example:

ENTER	COMMENTS:
AC <c>	Clear User Program
E <cr>	Enter Editing mode, Indexer responds < 503 bytes free.
B2 [1 SK5=0, Y0 S J35]	Define input scan #1, when K5 goes low, set Y=0, stop motion then jump to block 35. (Limit Switch detection routine)
B3 F300 Y=0 CC1.0 ZR0	Set initial condition: Start/stop speed, output Ys, Current control and reset position counter. ZRO may be replaced by H+ or H- if available.

```
B6  J10(K1=0) J20(K2=0) J30(K3=0)  J6
```
Select move block based upon input K. If K1-3 are high, loops back to B6 (Conditional and unconditional jumps)

```
B10  W.5 I +10000 V4000 T.1 Y=1 6
```
(Multiple moves start here if (K1=0). Set and start 1st Index move, set Y=1

```
B12  W.5 V6000 -15000 Y=2 G
```
Set and start 2nd Index mover, set Y=2. Set dwell time to .5 second.

```
B14  V8000 +25000 T.2 Y=3 G
```
Set and start 3rd Index move, set Y=3

```
B16  J10(1) W1 Y=0 HE J6
```
Repeat multiple moves from B10 one more time. Wait 1 second, clear Y then return to electrical home. Jump to B6.

```
B20  V2000 +T.1 R Y=4 W.3
```
Set Run move, ramp slope, Y4=1 Go on trigger start here if K2=0

```
B22  G (N1500 V3000, N4000 V6000, N9000 V4000, N1400 S)
```
At full step distance N=1500 change velocity to 3000 sps, at N=4000 change velocity to 6000 sps and so on. At last when N=14000 ramp down to stop. Note the total distance traveled is 14000 full step + the ramp down distance from V4000 to start/stop rate

```
B25 HE J6
```
Return to Elec. home then jump to B6

```
B30  R V1000 T.05 Y=16
```
Set up Go on trigger if K3=0

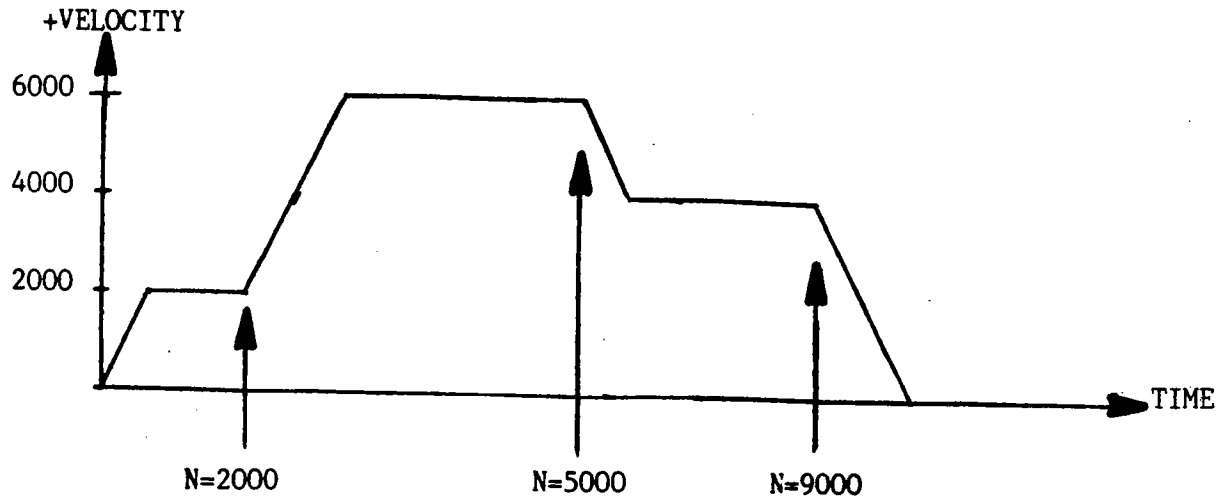
```
B32  G(W.3 V2000, N5000 V3000, N7000 Y1=1, W1 V6000, W2 V4000, W1 S)
```
Velocities change using W and N (mixed). This is similar to B22 move except that at N=6000 set Y1 to logic high.

```
B33   W.3  Y=0  HE  J6
```
Wait .3 sec. set Y=0, return to electrical home then jump to B6

```
B35  W.25 Y3=1 W.25 Y3=0 J35(10)
```
Program jumps here whenever K5=0

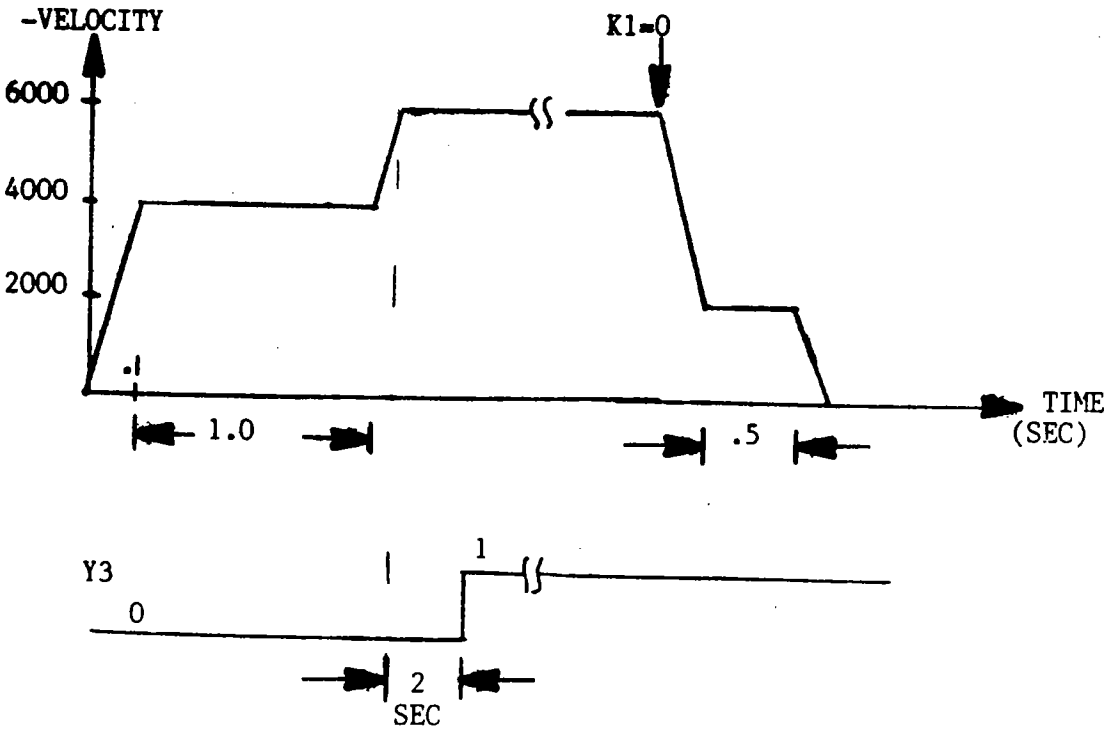
```
                    Flashing Y3 on and off 10 times at
                    the rate of .5 sec then exit program.
                    (Exit editing mode)

B38 END
```



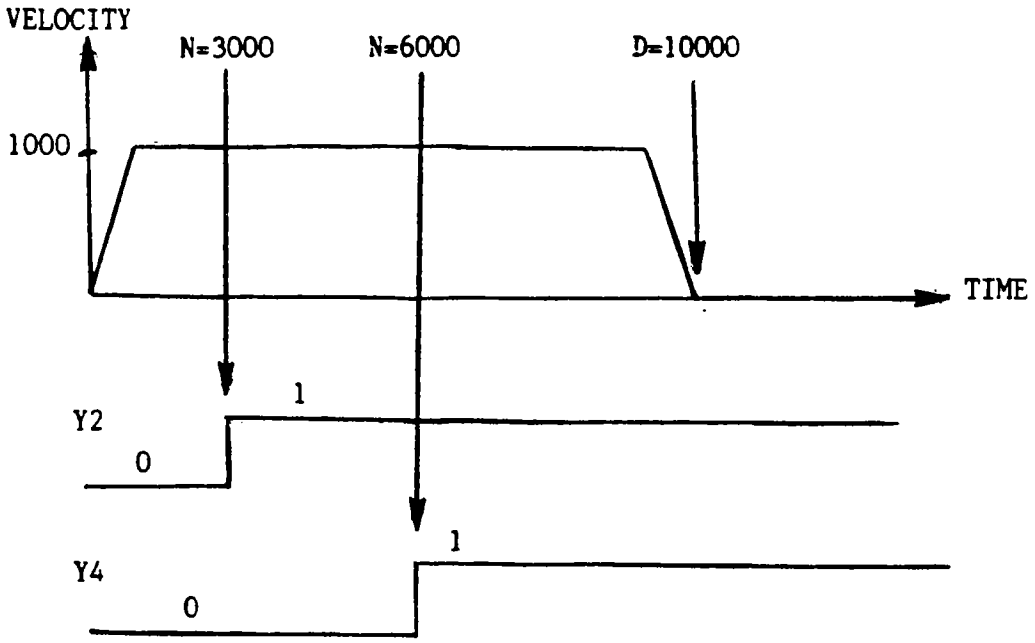
V2000 T.02+RG(N2000 V6000, N5000 V4000, N9000S)

Figure 5.2



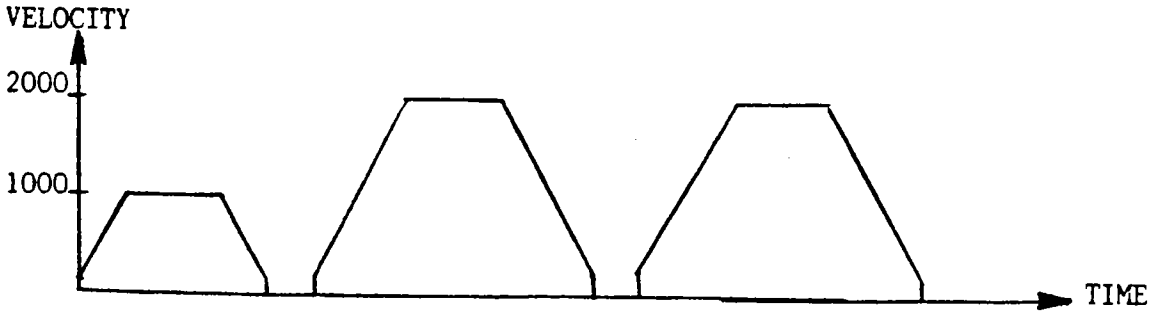
V4000 T.1-RG (W1 V6000, W2 Y3=1, K1=0 V2000, W.5S)

Figure 5.3



I D10000 V1000 T.1G(N3000 Y2=1, N6000 Y4=1)

Figure 5.4



T.1 F100 V1000 D2000 G W.1 V2000 D5000 C2G

Figure 5.5

```
B1 I F100 V1000T.1
B5 J10 (K1 = 0) J15
B10 D1000 G W2 J5
B15 D2000 G W1 J5
```

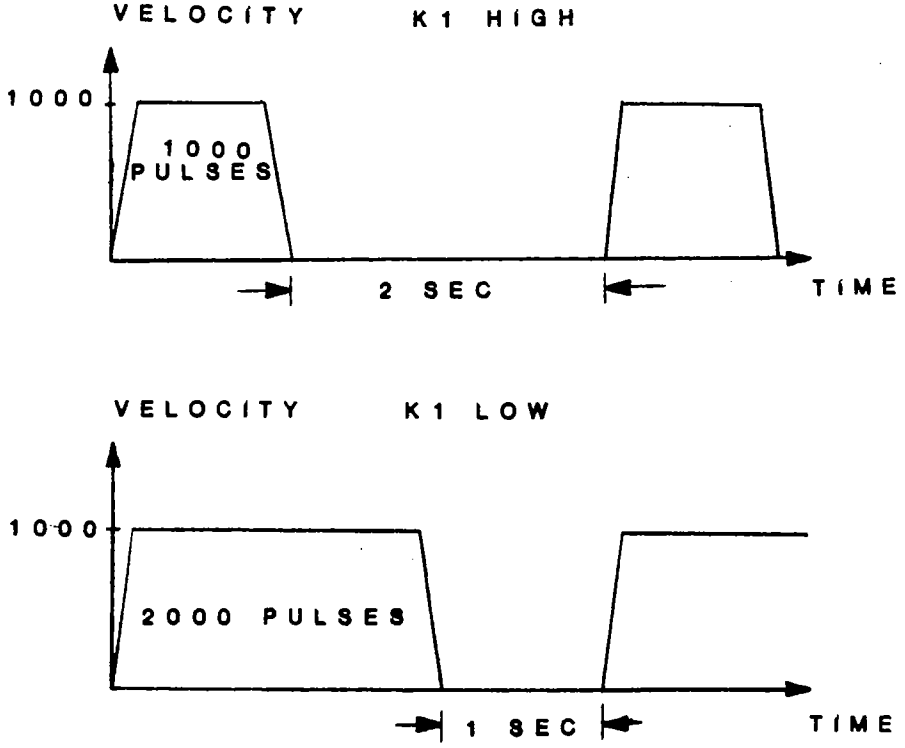


Figure 5.6

SECTION 6

SERIAL AND PARALLEL COMMUNICATIONS

This section describes the timing requirements for the serial and parallel communications ports of the 5440 as well as multi-axis communication using either port.

Section 3.2 gives the pinout of J2, used for serial data input and output. Serial data input and output circuits are shown in Figs. 3.1C and 3.1D. The serial port baud rate is set by jumpers W1 and W2 as described in Section 4.1.

Section 3.1 gives the pinout of J1, used for parallel data input and output. The parallel data input circuit is shown in Fig. 3.1A, the Data Valid/ input circuit is shown in Fig. 3.1B, and the Acknowledge/ and I Run/ output circuit is shown in Fig. 3.3

Section 3.4 gives the pinout of J4, used for serial repeat connection of multiple drives (in addition to the remote programmable inputs, outputs and indexer status outputs).

6.1 Serial Data Timing

The RS232 UART serial input port is a fundamental part of the 5440 operation. The serial data is fed to the unit using standard ASCII Format, 1 start bit, 8 data bits, 1 stop bit and no parity bit. Refer to Figure 6.1.

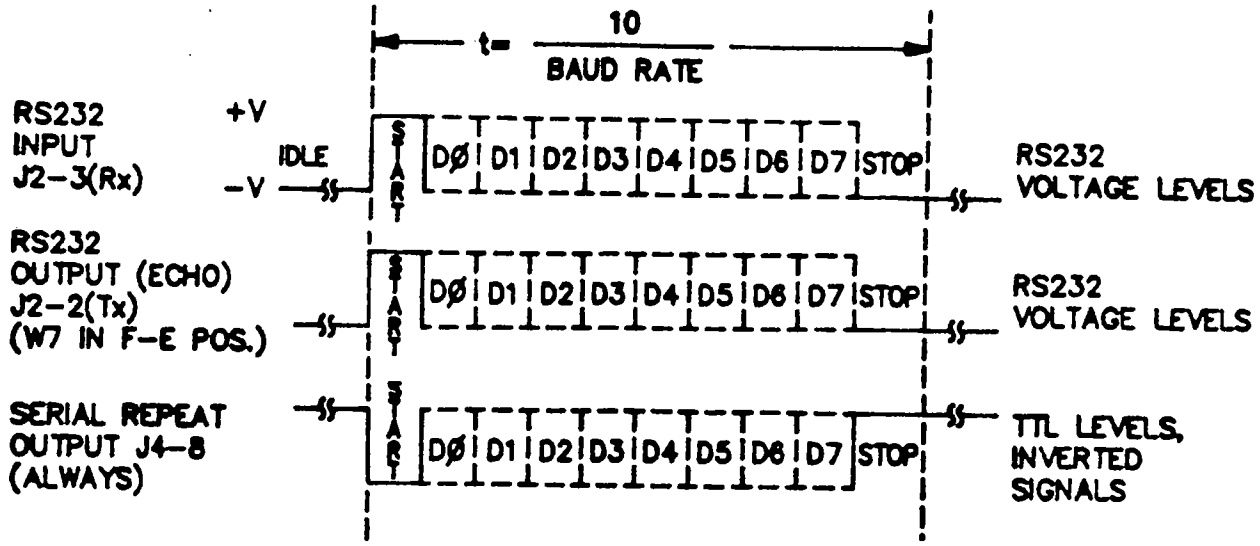


FIGURE 6.1

Serial Data Timing Diagram

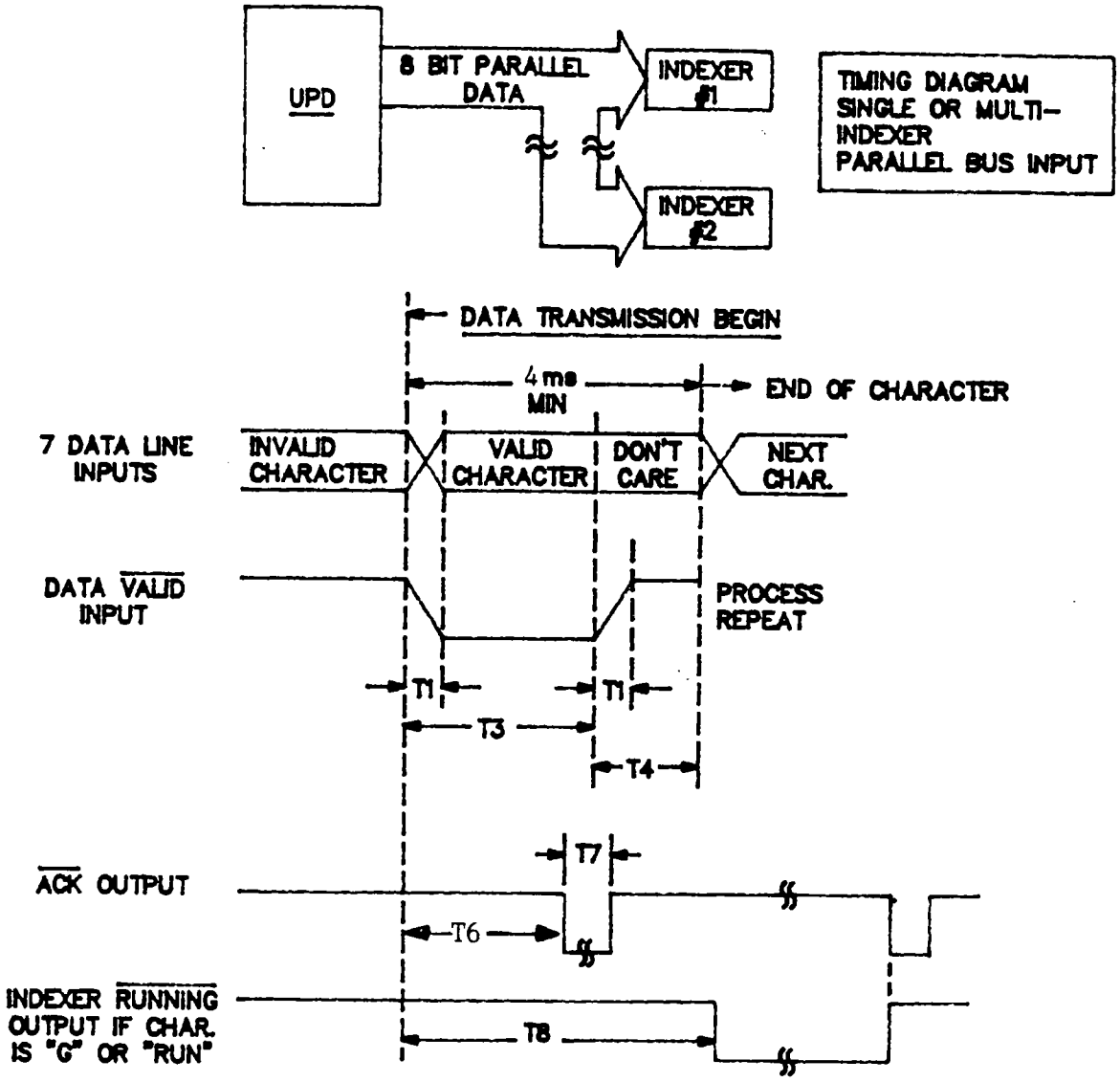
6.2 Parallel Data Timing

The parallel data link uses standard ASCII format, 7 data bits are used and 1 data-valid bit. The 7 data bits are the Binary bit pattern of the ASCII character. The DATA VALID bit is provided to transfer data bits to the internal bus.

The timing sequence described here and shown in Fig. 6.2 must be followed. The 7 data lines must be held for a minimum of 4 ms from the time DATA VALID goes low. The high-to-low transition of DATA VALID/ can either be simultaneous with the 7 data lines becoming valid or can occur after the data has been set. The DATA VALID/ line must be low for a minimum of 2.5 ms. This line must go high for a minimum 1.5 ms before the next character can be entered. The maximum data rate is 250 characters / second.

On receiving a valid charter the ACK/ signal will pulse low for either 50ms or 500us depending upon Jumper W5 (See Section 4.1).

The I RUN/ signal will go low 20 ms after a GO command has been accepted. The time from the transition of I RUN/ to the first motor drive pulse will be one-half the period of the start/stop rate (Fxxx). Refer to Figure 6.2.



T1 = Transition Time, 0.3 mS max.
T3 = Data Valid Low 2.5 mS min.
T4 = Data Valid High 1.5 mS min.
T6 = Data Valid Low to Ack Out 1.5 mS max.
T7 = Ack Pulse Width (500 s or 50 mS)
T8 = Data Valid to Motor Running Output 20 mS

Figure 6.2

Parallel Data Timing Diagram

6.3 Multiple Axis Communications

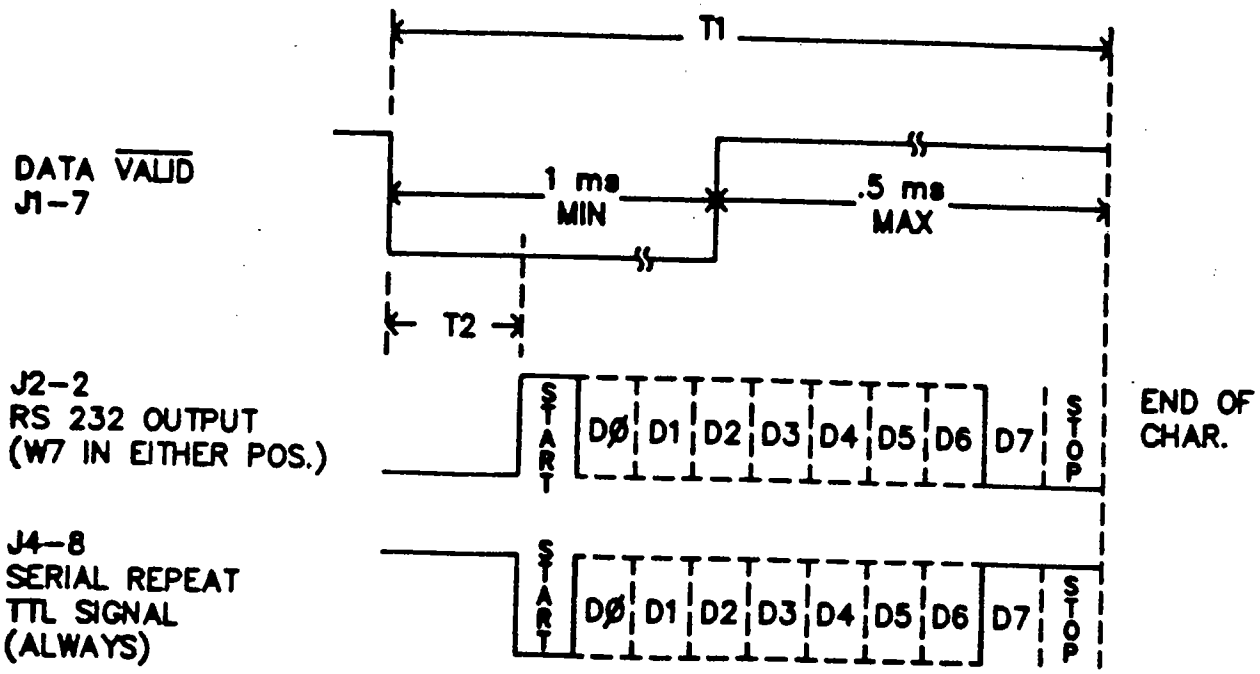
Up to eight 5440's can be connected to one command source (User Programming Device) on either the serial or parallel port. Each 5440 would have a unique identification code set via dip switches (Refer to Section 4.3 and 5.3 for detailed information on setting the indexer address.).

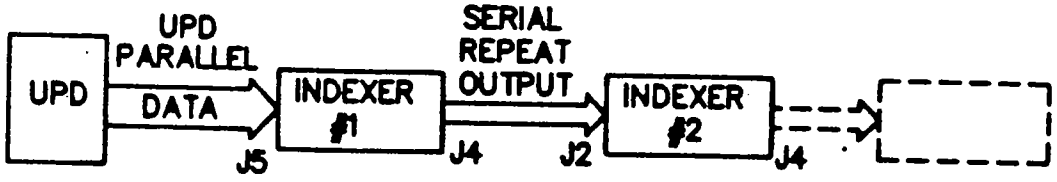
A data repeat signal is used for series connected (daisy chained) units. Any characters received from the serial or parallel input ports of one unit are transmitted (repeated) serially at the serial repeat output. The serial repeat output is a TTL signal inverted from the normal RS-232 logic sense and is only intended to drive the serial repeat input (J2 pin 10) of the next 5440 in the daisy chain. The serial repeat input is optically isolated to avoid ground loops between indexers. The maximum baud rate of the serial repeat is 4800 baud. All daisy chained 5440's must be set to the same baud rate.

The repeat serial format is one start bit, 7 data bits, one stop bit and no parity. The data repeat signal is generated by either serial or parallel input. The data rate (characters per second) of the parallel input must be a maximum of one-tenth the baud rate to ensure that the previous character has been repeated. Refer to figures 6.1 and 6.3.

For serial input there is only one method of connecting multiple units which is through the serial data repeat signal. See Fig. 6.4 for connection diagram.

With parallel input there are two options for multiple axis communications, the first of which is shown in fig 6.2. The parallel inputs of each 5440 are driven directly by the UPD (Users Programmable Device). The second option is shown in Fig. 6.3 where the first 5440 is driven at the parallel input. The additional units are driven from the serial repeat line. The repeat signal connections are shown in fig. 6.4.

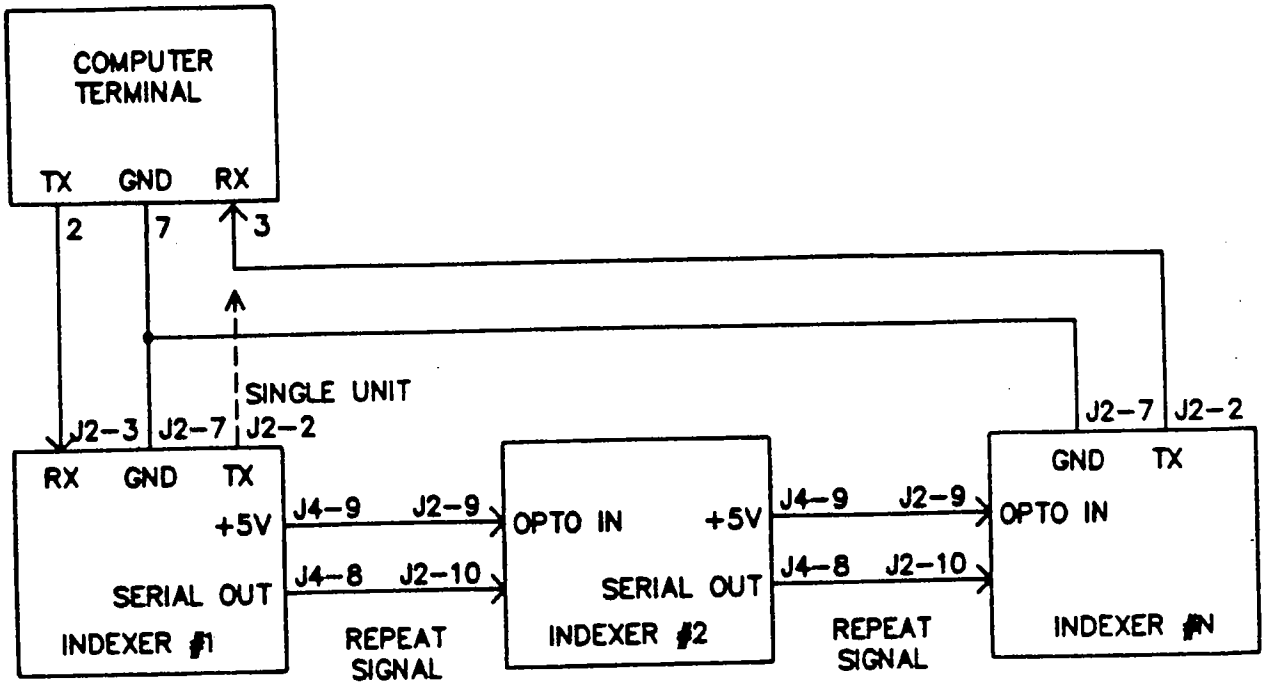




NOTE: $T_1 \geq \frac{10}{\text{BAUD RATE}}$

Figure 6.3

Parallel Data and Repeat Signal Output Timing Diagram



NOTE:

In this configuration, Indexer #1 and Indexer #N (first and last) are grounded together through the terminal.

Figure 6.4

Multiple Axis Serial Repeat Connection

SECTION 7

INSTALLATION/SET-UP

Due to the wide variety of uses for the 5440, it is the responsibility of the user or those applying the unit to determine the suitability of this product for any intended application. In no event will Pacific Scientific Company be responsible or liable for indirect or consequential damage resulting from the use of this product.

The figures, tables, and examples shown in this manual are intended solely to supplement the text. Because of the varied requirements of any particular application, Pacific Scientific Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications included in this manual.

WARNING

DANGEROUS VOLTAGES, CURRENTS, TEMPERATURES, TORQUES, FORCES, AND ENERGY LEVELS CAN EXIST IN THE PRODUCT AND ITS ASSOCIATED STEPPING MOTOR. EXTREME CAUTION AND CARE SHOULD BE EXERCISED IN THE APPLICATION OF THIS EQUIPMENT. ONLY QUALIFIED INDIVIDUALS SHOULD WORK ON THIS EQUIPMENT AND ITS APPLICATION.

7.1 Unpacking and Inspection

Remove the 5440 from its shipping carton and check the items against the packing list. A nameplate located on the side of the unit identifies the unit by model number, serial number, and date code.

Inspect the unit for any physical damage that may have been sustained during shipment. All claims for damage whether concealed or obvious must be made to the shipper by the buyer as soon as possible after receipt of the unit.

Remove all packing materials from the unit. If the unit is to be stored, it should be stored in a clean, dry place. The storage temperature must be between -55 degrees C and 85 degrees C. To prevent damage during storage, it is recommended that the unit be stored in its original shipping carton after completing inspection for damage.

7.2 Mounting

Figure 2.1 shows the mechanical outline of the 5440. Mounting is accomplished by three slots located on the unit. The unit must be mounted vertically on a flat, solid surface taking into account its weight of approximately 18 pounds. Recommended mounting hardware are 1/4-20 bolts.

The unit should not be subjected to excessive vibration or shock. The environment should be free of corrosives, moisture, and dust. Refer to Section 2.3 for the environmental specifications of the 5440. To insure proper cooling, there must be a minimum unobstructed space of 4 inches above and below the unit and 1 inch on each side.

Since this unit is of "open frame" construction, it should be located within an enclosure to protect it from physical or environmental damage. The unit will fit in a standard 8 inch deep NEMA enclosure for industrial applications.

7.3 Interconnection Wiring

Figure 7.1 illustrates the interconnection wiring of the 5440 to a stepping motor, RS-232 terminal, Parallel Input Device, and I/O equipment.

Wiring sizes, wiring practices, and grounding/shielding techniques described in this manual are intended as a guideline only. Due to the variety of applications served by this product, no single method of interconnection is universally applicable. The information included in this manual represents common industrial wiring practices and should prove satisfactory in the majority of applications. However, local electrical codes, special operating conditions, or system configurations should take precedence over the information provided herein.

To reduce the possibility of noise pickup, power and signal wiring should be routed separately. Signal wiring should be shielded. Motor phase wiring should be twisted to reduce radiated noise. The gage used for motor phase wiring is determined by the length required. For lengths of 10 feet or less, #16 (or lower gage) wire is recommended. For lengths greater than 10 feet, #14 (or lower gage) wire should be used.

To minimize shock hazard, all components should connected to a common earth ground point.

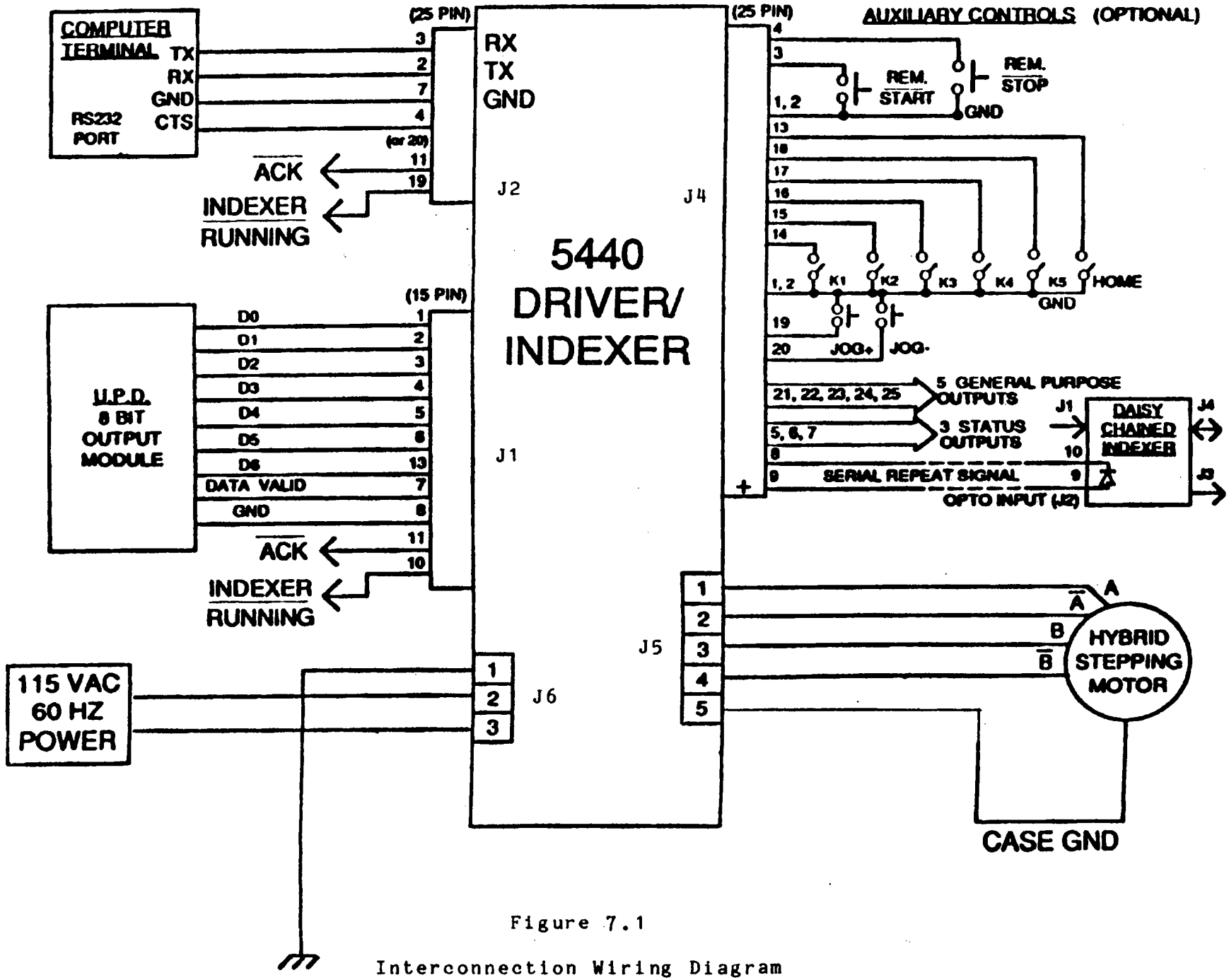


Figure 7.1

Interconnection Wiring Diagram

7.4 Initial Power Up

Every 5440 is burned-in and fully tested before leaving the factory. However, it is possible that damage has been sustained by the unit during shipment. This procedure should be followed to insure that the unit has not sustained shipping damage and has been installed properly.

The initial power up sequence makes use of a terminal to communicate with the 5440 over the RS-232 serial port. This procedure assumes that the software parameters are set to factory default values.

WARNING

THIS INITIAL POWER UP PROCEDURE SHOULD BE PERFORMED WITH THE MOTOR SHAFT DISCONNECTED FROM THE LOAD. IMPROPER WIRING OR UNDISCOVERED SHIPPING DAMAGE COULD RESULT IN UNDESIRED MOTOR MOTION. BE PREPARED TO REMOVE POWER IF EXCESSIVE MOTION OCCURS.

(1) Verify that the unit is wired and mounted per instructions in this manual. Be especially careful in checking the 120 VAC input connections and the motor connections.

(2) Verify that the plug jumper settings are per the following:

Indexer	W1	Set to match the baud rate of
	W2	the terminal being used to communicate with the 5440.

(3) Unplug the J5 motor connector. Make sure 120 VAC power is OFF when you do this.

(4) Apply 120 VAC power. Verify that the green power LED is on.

(5) Send Q <CR> to the 5440 via the serial port.
The 5440 should respond with the following message:

```
<
<  ID= 0 ,  STEP SIZE= 1\1
<
<  ST=00000000 , POS= 0
<  K=11111 , Y=11111
<
```

```
< F 25 , V 25 , T 1.0 , D 0
< W 0 , CI 1.0 , CR 1.0 , CB 1.0
```

If no response is received check to the following:

a. RS232 transmit and receive lines are not reversed.

b. RS232 ground connection is connected to the correct pin at the host and J2-7 on the indexer.

c. The baud rate of the host and indexer match.

d. The host communications parameters match those of the indexer: no parity, 1 start bit, 7 data bits and 1 stop bit.

e. On some host systems certain handshaking lines need to be tied to a logic high state or another handshaking line. Connections to try:

   i) Indexer J2-4 to CTS on host system.

   ii) On host (25 pin connector) pin 4 to pin 5, pin 6 to pin 20, pin 4 to pin 5 to pin 8, either/or.

   iii) On host RTS to CTS, DTR to DSR.

(6) Remove 120 VAC power from the unit.

(7) Plug the J5 motor connector into the unit.

(8) Apply 120 VAC power to the unit.

(9) Force the +JOG input to the low state. The motor should rotate slowly in a positive direction. Allow the +JOG input to return to the high state. Motor rotation should cease.

(10) Force the -JOG input to the low state. The motor should rotate slowly in a direction opposite that which occurred with +JOG low. Allow the -JOG input to return to the high state and verify that motor motion ceases.

(11) Send the command RV2000G <CR> to the 5440 via the serial link. The motor should begin to rotate. Send S <CR>. The motor rotation should cease.
Send -G<CR> the motor should rotate in the reverse direction. Send S<CR> motor motion should cease.

If the unit successfully passed the above procedure, you may now try exercising the unit on your own. Refer to Section 5 for

information on how to program the unit or use commands in the immediate mode.

SECTION 8

CONNECTIONS SUMMARY

8.1 J1 - PARALLEL INTERFACE

J1 - 1	:	Data 1 (LSB)
J1 - 2	:	Data 2
J1 - 3	:	Data 3
J1 - 4	:	Data 4
J1 - 5	:	Data 5
J1 - 6	:	Data 6
J1 - 7	:	Data Valid
J1 - 8	:	Ground
J1 - 9	:	+5 VDC
J1 - 10	:	I RUN
J1 - 11	:	Acknowledge
J1 - 12	:	Not Used
J1 - 13	:	Data 7 (MSB)
J1 - 14	:	Not Used
J1 - 15	:	Not used

8.2 J2 - RS232 SERIAL INTERFACE

J2 - 1	:	Not Used
J2 - 2	:	Transmit Data (Tx)
J2 - 3	:	Receive Data (Rx)
J2 - 4	:	RTS (not active)
J2 - 5	:	Not Used
J2 - 6	:	Not Used
J2 - 7	:	Ground
J2 - 8	:	Not Used
J2 - 9	:	+5 VDC
J2 - 10	:	Serial Repeat Input (Rx2)
J2 - 11	:	Acknowledge
J2 - 12	:	Not Used
J2 - 13	:	Not Used
J2 - 14	:	Not Used
J2 - 15	:	Not Used
J2 - 16	:	Not Used
J2 - 17	:	Not Used
J2 - 18	:	+5 VDC
J2 - 19	:	I RUN
J2 - 20	:	DTR (not active)
J2 - 21	:	Not Used
J2 - 22	:	Not Used
J2 - 23	:	Not Used
J2 - 24	:	Not Used
J2 - 25	:	SCLK

8.3 J4 - I/O INTERFACE

J4 - 1	:	Ground
J4 - 2	:	Ground
J4 - 3	:	Remote Start
J4 - 4	:	Remote Stop
J4 - 5	:	M RUN
J4 - 6	:	Acknowledge
J4 - 7	:	I RUN
J4 - 8	:	Serial Repeat (Tx2)
J4 - 9	:	+5 VDC
J4 - 10	:	+5 VDC
J4 - 11	:	Not Used
J4 - 12	:	Not Used
J4 - 13	:	Home Sensor Input
J4 - 14	:	K1 Programmable Input #1
J4 - 15	:	K2 Programmable Input #2
J4 - 16	:	K3 Programmable Input #3
J4 - 17	:	K4 Programmable Input #4
J4 - 18	:	K5 Programmable Input #5
J4 - 19	:	Jog +
J4 - 20	:	Jog -
J4 - 21	:	Y1 Programmable Output #1
J4 - 22	:	Y2 Programmable Output #2
J4 - 23	:	Y3 Programmable Output #3
J4 - 24	:	Y4 Programmable Output #4
J4 - 25	:	Y5 Programmable Output #5

8.4 J5 - MOTOR CONNECTOR

J5 - 1	:	Motor Phase A
J5 - 2	:	Motor Phase A
J5 - 3	:	Motor Phase B
J5 - 4	:	Motor Phase B
J5 - 5	:	Common

8.5 J6 - 120 VAC POWER INPUT

J6 - 1	:	Chassis Ground
J6 - 2	:	120 VAC Input
J6 - 3	:	120 VAC Input

SECTION 9

JUMPER AND SWITCH FUNCTION SUMMARY

9.1 INDEXER SELECTABLE FUNCTIONS (refer to Fig. 4.1)

S1 - 1 : Microstep Setting (refer to Section 4.2)
S1 - 2 : Microstep Setting
S1 - 3 : Microstep Setting

S1 - 4 : Unit Address (refer to Section 4.3)
S1 - 5 : Unit Address
S1 - 6 : Unit Address

W1 : Baud Rate (refer to Section 4.1)
W2 : Baud Rate

W3 : Configuration Jumper (J-H position)

W4 : Remote Start Switch Function
J-H = Run (program)
J-L = Go (immediate)

W5 : Acknowledge Output Pulse Width
A-F = 500 Microseconds
A-S = 50 Milliseconds

W6 : Configuration Jumper (INT position)

W7 : Echo-Back On Serial Link
F-E = Echo Enabled
F-D = Echo Disabled

9.2 DRIVE SELECTABLE FUNCTIONS (refer to Fig 4.2)

SW1 - 1 : Microstep Setting (refer to Section 4.3)
SW1 - 2 : Microstep Setting
SW1 - 3 : Microstep Setting

SW1 - 4 : Microstep Current Boost Above 500 SPS
Closed = Enable Current Boost
Open = Disable Current Boost

SW1 - 5 : Mid-Range Stability Control
Closed = Disable Stability Control
Open = Enable Stability Control

SW1 - 6 : Idle Current Reduction
Closed = Disable Idle Current Reduction
Open = Enable Idle Current Reduction

SECTION 10
COMMAND SUMMARY

Summary of Indexer Commands

10.1 Programming and Edit Commands (Note: <cr> specifies carriage return.)

Command	Description	Command Type
AC <cr>	Clears memory and resets indexer to power-up state.	immediate
Bxx	Program block number	program
Exx <cr> E <cr>	Enters editing mode.	immediate
<ESC> \#	Exits editing mode	immediate
End	Termination program execution	program
L <cr> Lxx <cr>	Lists users program	immediate
LFx <cr>	Enables or disables line feed after carriage return	immediate
PS <cr>	Stores users program into non-volatile memory	immediate
PR <cr>	Recalls users program from non-volatile memory	immediate
Q QP QS	Returns parameter and status information	immediate
Runxx <cr> Run <cr>	Starts program execution	immediate
/	Delimiter user before indexer address	immediate
TRx <cr>	Trace command, returns block program as indexer is executing.	immediate

10.2 Motion Control Commands

Command	Description	Command Type
Cxxxxx	Specifies number of single-index move cycles	immediate/ program
CS	Initiate ramped deceleration at end of cycle and exits program	immediate/ program
Dxxxxxxx or ±xxxxxxx	Distance value used for index moves	immediate/ program
Fxxx	Start-stop velocity	immediate/ program
G	Initiate the start of a move	immediate/ program
I	Specifies index move	immediate/ program
Nxxxxxx	Specifies full-step count value used as program trigger event	program
P±xxxxxxxx	Absolute Move	immediate/ program
R	Specifies ramped velocity move	immediate/ program
S	Initiate immediate ramped deceleration and exits program	immediate/ program
Tx.xx	Specifies ramp time	immediate/ program
Vxxxxx	Specifies full-step velocity	immediate/ program
Wxx.xxx	Specifies wait time	immediate/ program
X	Specifies continuous cycling	immediate/ program

10.2 Motion Control Commands (cont.)

Command	Description	Command Type
+	Positive direction	immediate/ program
-	Negative direction	immediate/ program

10.3 Home and Position Counter Commands

Command	Description	Command Type
HE	Return to electrical home	immediate/ program
HM	Return to mechanical home	immediate/ program
H+	Search for mechanical home in + direction	immediate/ program
H-	Search for mechanical home in - direction	immediate/ program
[Hx]	Sets home switch true level	immediate (power up)
[PO+xxxxx]	Specifies position offset of electrical home relative to mechanical home.	immediate (power up)
ZR+xxxxxxx	Initializes relative position counter to specified value	immediate/ program

10.4 Current Control and I/O Commands

Command	Description	Command Type
CCx	Global current value	immediate/ program
K = xx	Test inputs (K) in combination against 5 bit code (xx).	program
KZ = x	Test single input (KZ) against logic level(x)	program
Y = xx	Set outputs (Y) in combination to 5 bit code (xx).	immediate/ program
YZ = x	Set single output (YZ) to logic level (x)	immediate/ program