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Compumotor

Model 430 Indexer User Guide

Compumotor Division
Parker Hannifin Corporation
p/n 88-003360-03 C

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Compumotor

Operator's Manual

430 TROUBLESHOOTING GUIDE
P/N: 88-006107-01

Parker Hannifin Corporation
Compumotor Division
1179 N. McDowell Blvd.
Petaluma, CA 94952 USA

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1.0 INTRODUCTION

This guide is intended to be helpful when experiencing problems with a model 430 indexer. The assumption has been made that the problem is related to the hardware of the 430 indexer, motor/drive, or any external devices interfaced to the 430. If the problem you have is related to programming the 430, refer to Section 2.3.2 for assistance. Programming command list is provided in Figure 2-0 for an easy reference.

1.1 Test Equipment

Before you begin troubleshooting the 430, you should have the following equipment available:

1. Small screwdriver
2. Model 431 programmer
3. Wire for jumpers
4. Voltmeter

The following equipment is optional, but desirable:

5. Terminal with RS-232 transmission
6. Spare Model 430
7. Spare motor/drive
8. Oscilloscope

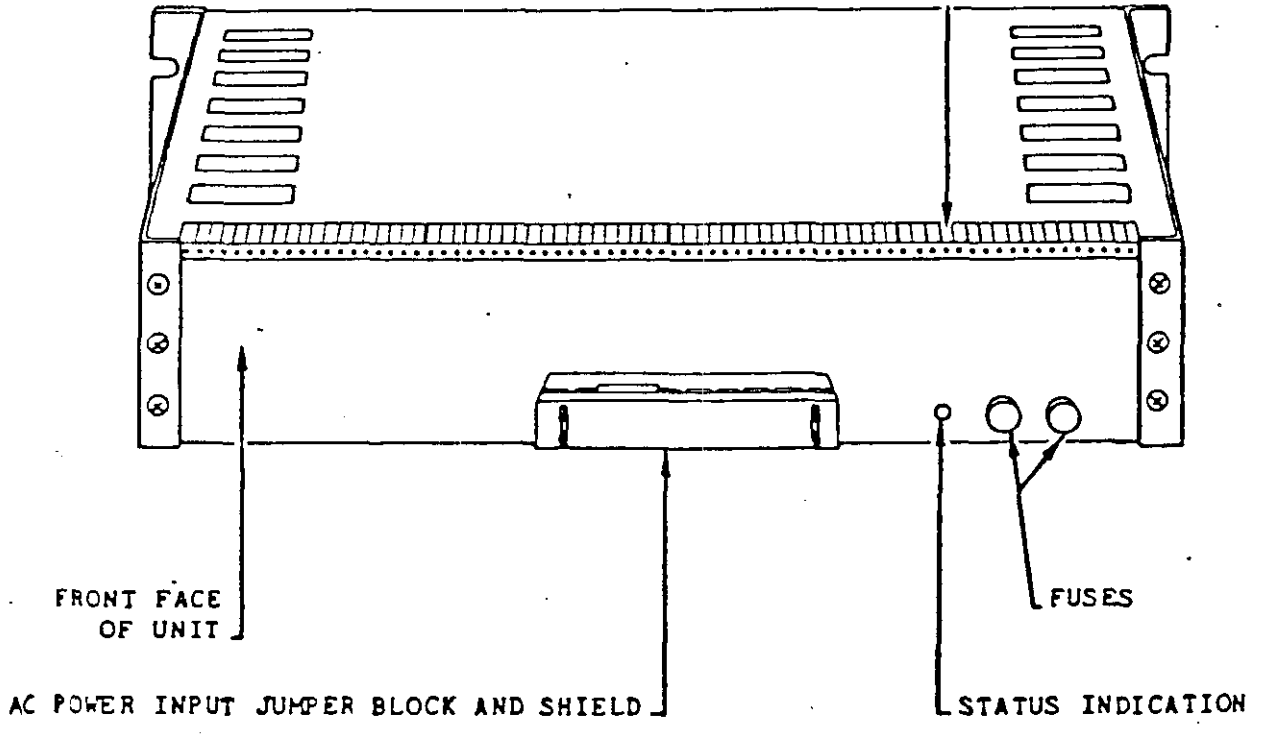


Figure 1-1

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2.0 LED DIAGNOSTIC INDICATORS

The 430 has a two-color LED on the front panel (see Figure 1-1) which gives you a quick visual indication of the indexer's condition. The LED can be in one of three possible states: LED OFF, LED RED, or LED GREEN. Refer to Figure 1-2 for a pictorial representation of these conditions.

LED OFF - Indicates that there is no power to the 430's power supply. See Section 2.1 for a further description.

LED RED - Indicates that power is on and that the board monitor alarm has been activated. This means that the microprocessor is not executing its programs properly. See Section 2.2 for further description.

LED GREEN - Indicates that the power is on and that the microprocessor is functioning properly. See Section 2.3 for a further description.

The following sections outline in further detail the possible causes and solutions for each of the above conditons.

2.1 LED Off

2.1.1 AC Power Missing

Check 430 power terminals for correct AC voltage as illustrated in Figure 1-3, then check the wiring from AC power source and reapply power. CAUTION: Be sure to disconnect AC voltage before checking wiring. If AC connections are correct, proceed to next section.

The 430 Operation Manuals up to and including Rev. C have indicated AC power wiring configurations for 100 V and 220 V. These configurations will damage the power supply and should not be used.

2.1.2 Line Fuse Blown

Remove power from the 430 and check AC line fuses for continuity. Refer to Figure 1-1 for fuse location. If a fuse is blown, replace and reapply power. It is likely that a short exists in the 430 power supply if the replacement fuse immediately fails. If this occurs, return faulty unit for repair. See Section 3.0 for return materials assistance. If fuses are intact, continue to next paragraph.

2.1.3 Faulty Power Supply

There is also the possibility of a faulty power supply or some open circuitry. Remove cover and verify that the two ramp-style connectors which carry power from the two 5 volt power supplies to the circuit board are attached. Refer to Figure 1-4 for location of these connectors. If the connectors are in place and the LED is still off, return unit for repair. See Section 3.0 for return materials assistance.

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2.2 LED Red

2.2.1 Contact Bounce

Early versions of the 430 could experience intermittent faults if contact bounce of a certain frequency was present on any strobe input, or on trigger one. This can be eliminated by upgrading the 430 software to the latest revision. As of May 1, 1986 the latest software revision for the 430 is number 92-5012-11C/-01C. Refer to Figure 1-4 and for location of PROM's on circuit board part numbers illustrated. When you are examining the PROM's, check to ensure that the chips are installed properly. The chips have a small notch on one end. This notch should be facing away from the screw terminal connections. Also check the chips for proper insertion. If all of the legs of the chips are not completely inserted, the PROM's will not perform as required. Contact Compumotor's application engineering department at 1-800-358-9068 for the most recent set of PROM's if new revision software is required. If the PROM's are 92-5012A or later, proceed to next dipswitch and jumper check.

2.2.2 Dipswitch and Jumper Settings

On 430's with internal CPU circuit cards labeled "PCA 71-003270-01/-02", dipswitch SW9 positions 5 and 6 must be ON for boards to operate properly, while positions 7 and 8 must be OFF. Refer to Figure 1-4 for the location of switches and jumpers on the 430's circuit board. Refer to Figure 1-5 and for proper dipswitch and jumper settings. On CPU circuit cards labeled "PCA 71-003270-03", switch SW9 is a four position switch with two jumpers, JU9 and JU10, added. Make sure these jumpers are on the left side of the circuit board when viewing the screw terminal end of 430. When checking dipswitches and jumpers, make sure each setting is either completely ON or OFF. Be careful not to set a dipswitch to a halfway ON/OFF setting. If jumpers and dipswitches are in the correct positions, cycle power and proceed to the following paragraph if red light still exists. If a green light is now present, proceed to Section 2.3.

2.2.3 Cold Start

If the Red LED came on immediately after power-up, it may be due to a malfunctioning clock chip on the 430. Some 430's were built with Fujitsu 8284 clock chips. Some of these chips fail to operate properly with the 430 design until they are on for approximately 30 minutes. Malfunctioning 430's with Fujitsu 8284 chips should be returned to the factory for repair. A Fujitsu chip has a big "F" stamped on it for identification. This chip is found near the microprocessor. If the Fujitsu chip is present on circuit board, we suggest that the unit be sent back for update.

2.2.4 Electrical Noise

When the red LED comes on intermittently, it usually indicates the presence of extreme electrical noise. Check the connections from the 430 to the motor/drive (terminals 53-66) to ensure that all cabling is shielded and that one end of the shield is connected to earth ground. If intermittant failures persist, it may be necessary to identify and suppress possible sources of noise (i.e. inductive loads such as relays, solenoids or motor starters). You should always avoid routing 430 cabling in close proximity to high voltage

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wiring. Also, if you are using a 430 output to drive a relay type load, be sure to shunt back-EMF from the relay with a diode. This will prevent excessive voltage from being fed back into the output and consequently blowing the output. Continue to next paragraph if red LED condition still exists. NOTE: All indexer grounds should be terminated at the same point.

2.2.5 Microprocessor Fault

The red LED indicates that the microprocessor is not able to execute any commands. This is most likely due to some sort of component failure. Cycle the power or reset the 430 by pulling the reset terminal 24 to ground. If the LED immediately turns red again, return faulty unit for repair. See Section 3.0 for return materials assistance.

2.3 LED Green

If the LED is green and the system is not functioning properly, the problem is not likely related to the 430's hardware. When this occurs, we need to isolate the problem; the motor/drive or the user's interface. At this time a spare indexer and motor/drive would be useful in isolating the source of trouble. The sections below provide a description for each of the two LED green conditions and give possible solutions to the troubles being experienced. If the LED is green and there is no motion, see Section 2.3.1. If the LED is green and there is motion, see Section 2.3.2.

2.3.1 No Motion LED Green

2.3.1.1 Holding Torque

Attempt to turn motor shaft with power applied to determine if full torque is present. If no holding torque is present, check the AC power connections to the drive. Also, check to assure that remote power shutdown (terminal 32) is not grounded. Refer to the troubleshooting chart found in the motor/drive operations manual for help. If a spare motor/drive is available, connect the cable from the 430 to the spare drive and verify proper operation. If there still is no holding torque, go to faulty drive section. Otherwise, proceed to the next section.

2.3.1.2 Overtravel Limit Switches (EOT switches)

The CW and CCW limits on the 430 must be pulled to ground for motion to occur. Verify that these inputs are low with respect to ground with a voltmeter. If you read 5 volts on either of terminals 42 or 43, check the wiring from your limit switches. For proper operation, normally closed limit switches must be used for the motor to move. If limit switches are not installed, make sure that terminals 42 and 43 are jumpered to ground (terminal 22).

2.3.1.3 Jog Inputs

If overtravel limits are in place, use a jumper wire from ground to terminal 25 or terminal 26 inputs to see if the 430 causes the motor to jog in each direction. If the motor jogs in each direction, proceed to section 2.3.2. If the motor still does not move, reset the 430 by pulling terminal 24 to ground.

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Now try the jog process again. If motors still do not jog, proceed to the following section.

2.3.1.4 Test Move

Connect a Model 431 programmer to the 430. Remove the screw terminal block from pins 1 through 22 and place the screw terminal block connected to the 431 in its place. If you do not have a Model 431, contact your local distributor or Compumotor's application engineering department at 1-800-358-9068. See Figure 1-6 for location of switches on 431. This device should be connected to the low true end for proper interface with the 430 unless the 430 has been changed to operate on high true signals. Now place a 0255 on the thumbwheels and activate the command strobe (switch labeled CMD STB). This will cause the 430 to command the motor/drive to perform a one revolution move in the CW direction, and then a one revolution move in the CCW direction. The CW and CCW motor rotation is the movement direction when viewing the front end of the motor's mounting flange. After the CCW move is completed, the LED will turn red. When this occurs, simply reset the 430 by grounding terminal 24. If the above motion does not occur, connect 431 interface to 430 to the high true end and repeat the above proceedure. If the overtravel limits are not in place no motion will occur and the LED will turn red immediately. If the LED does not turn red immediately, but the motor does not move, the indexer/drive cable may be faulty. Repeat this test with a spare cable (refer to Section 2.3.1.2). If the 0255 move does not occur with 431 connected on low or high true, go to 431 functional test. Otherwise, see Section 2.3.2.3.

2.3.1.5 431 Functional Test

To check this, set the 431 on the low true end and put a 9999 on the thumbwheels. Now check the 430 bits 0-15 with a voltmeter for proper values. See Figure 1-7 for proper voltage readings on each bit. Repeat this proceedure with a 6666 setting on the thumbwheels. If voltages shown in the figure correspond to measured values, the 431 is fuctioning properly. If your 430 is configured to operate on high true signals, the voltages will be opposite from what is shown (i.e., 0 volts will be 5 volts and so on). If the voltages correspond now, proceed to the jog inputs section. However, if the voltages do not check, examine the wiring from the 431 to the 430 for proper connections and continuity. Now attempt the test move process again and proceed to next paragraph if no motion occurs.

2.3.1.6 Faulty Drive

If the motor has no holding torque, this is a good indication that the drive is faulty. The easiest way to determine this is to connect a spare drive to the 430, or monitor the pulse output with an oscilloscope. To check with a spare drive, disconnect the cable from the existing drive and connect it to the spare motor/drive. Check to see if this drive now has holding torque present. If the new motor/drive works, return faulty unit for repair. See Section 3.0 for return materials assistance. Make sure when you are connecting the new motor/drive that the cable is shielded and one end is connected to earth ground. If new drive functions properly, proceed to the next paragraph. If spare drive also does not function, go to pulse output failure.

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2.3.1.7 Pulse Output Failure

A spare indexer can be used to check the existing drive, or the step output on the 430 may be checked with an oscilloscope. If you have a spare 430 indexer available, connect it to the existing motor/drive to see if it operates properly. To check with a scope, first disconnect the motor/drive wiring from the STEP+ and STEP- terminals 59 and 60. Isolate your scope from AC ground. With your scope probes connected to terminals 59 and 60, you should see 5 volt positive going pulses. These pulses should be approximately one microsecond wide when the 430 is operating. If the system is operating properly, go to next section for programming assistance if desired. If the 430 is not sending pulses, return the unit for repair. See Section 3.0 for return materials assistance.

2.3.2 Improper Motion LED Green

This section is designed as a guide in troubleshooting the system when there is motion at the motor, but for some reason the system is not functioning properly. It makes the assumption that the problem is now related to programming the 430 indexer.

2.3.2.1 One Limit Switch Floating

If one limit switch is grounded and the other is not, the 430 will move the motor in one direction but not the other. The motors will be capable of moving in the direction of the limit that is grounded, but will not move in the direction of the ungrounded limit. If this seems to be the case, go to the limit switch section for assistance on checking the limit switches (Section 2.3.1). After the limits are checked, reset the 430 by pulling terminal 24 to ground. If this does not help the situation, proceed to the following paragraph.

2.3.2.2 Test Program

At this point, a terminal with RS-232 interface will be very helpful. If you have a terminal available, connect the interface as shown in Figure 1-8. A model 431 can also be used to strobe the test program into the 430. Refer to Figure 2-0 for the listing of all 430 programming commands as needed. If detailed information is needed, refer to the 430 Operator's Manual page number referenced next to each command. Before you begin the test program, reset the indexer by grounding terminal 24. Refer to Figure 1-6 for location of data registers if you are using the Model 431 to program the test move. When using Model 431 to strobe the information found below into each register, the 430 retains the most recently strobed data for each register. If the data for a given register does not change from one command to the next, the data does not need to be re-strobed for that register.

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REG1	REG2	REG3	REG4	CMDSTB	DESCRIPTION
0000	0000	0005	0000	0261	Set acceleration to 50,000 steps/sec/sec.
0000	0000	0005	0000	0262	Set velocity to 50,000 steps/sec.
0011	0000	0002	5000	0200	Define move #11.
0013	0000	0000	0000	0217	Define sequence #13 beginning point.
0011	0000	0000	0000	0064	Execute move #11.
0000	0000	0000	1000	0041	Delay for 1 second.
0011	0000	0000	0000	0064	Execute move #11.
0006	0000	0000	0000	0013	Turn on both outputs.
0000	0000	0000	0000	0216	Define sequence end.
0000	0001	0000	0000	0293	Enable autorecall.
0000	0000	0000	0000	0291	Save all parameters.

After you have entered this information, cycle power to the 430. Set the thumbwheel switches to read 13 and pull terminal 27, labeled SPECIAL, to ground terminal 22. This will cause the sequence you have entered to begin execution. The move performed should be a one revolution move in CW direction followed by a delay of one second, then one revolution move in CW direction with both outputs enabled after this move is completed. Check, with a voltmeter, terminals 30 & 31 for a 5 volt reading. If the entire program checks out, you have programmed one move and one sequence successfully. This also indicates that the 430's storage into memory and autorecall on power-up is functioning properly. If you need to erase all contents in the EEPROM, this is acomplished by inputting the information below to the 430.

REG1	REG2	REG3	REG4	CMD STB	DESCRIPTION
0000	0000	0000	0000	0293	Disable autorecall
0000	0000	0000	0000	0291	Save

The save program changes the entire contents of permanent memory to match the contents of the working memory. If the working memory is blank, the save program will blank the permanent memory. If the move was not executed as described above, refer to next paragraph.

2.3.2.3 Error Terminal Status

Jumper the pullups, terminal 46, to 5 volts, terminal 45, then check the error terminal, 23, with a voltmeter. When this pin reads +5 volts, it indicates that the indexer is functioning properly. A low voltage reading (.6 V) indicates a component failure in the 430. This output will go low if there is a failure in the EEPROM of in the static RAM.

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3.0 RETURN MATERIALS PROCEDURE

If your 430 indexer or motor/driver requires repair, follow the proceedure listed below for the most rapid turnaround.

1) Obtain the serial number of unit to be returned.
2) Obtain a purchase order number for returned units.
3) Contact the factory at 1-800-358-9068 for a return materials authorization number (RMA number).
4) Package unit in original package or equivalent protection for shipment. Include a note in the box stating the reason for return.
5) Write RMA number on the box before shipment.
6) Send boxed unit to:

COMPUMOTOR CORPORATION
1179 N. McDowell Blvd.
Petaluma, CA 94952

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LED TROUBLESHOOTING FLOW CHART WITH SECTION TOPICS

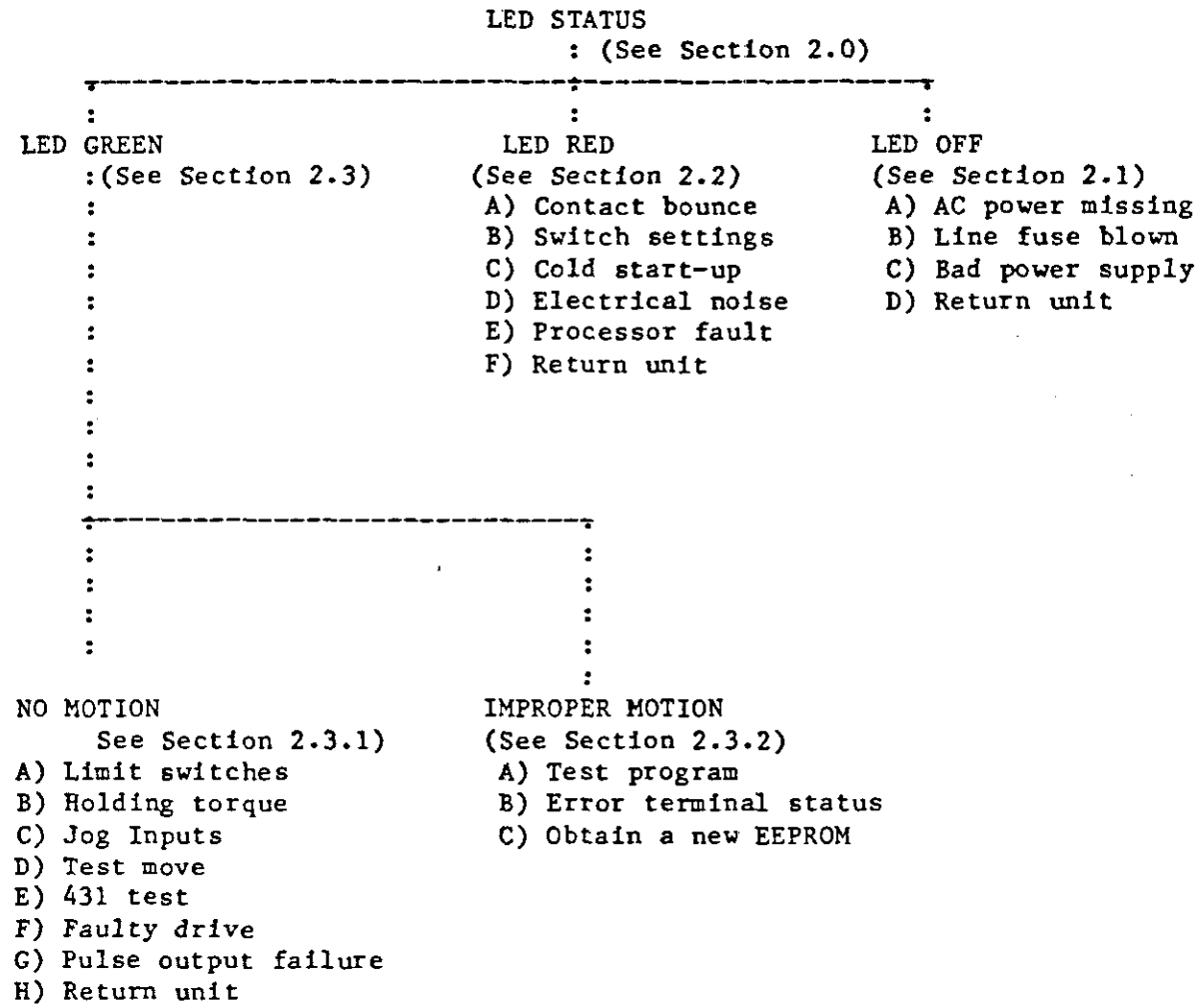
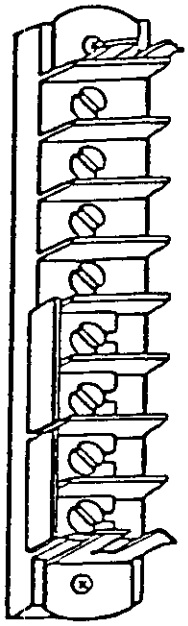


Figure 1-2

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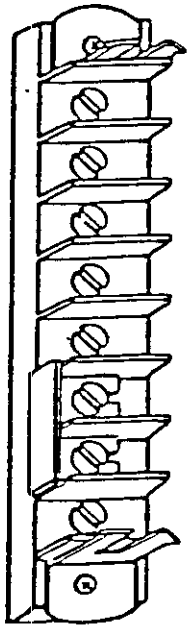


AC LINE -120 VAC (BLACK)

AC NEUT (WHITE)

AC GND (GREEN)

120 VAC *



AC LINE -240 VAC (BLACK)

AC NEUT (WHITE)

AC GND (GREEN)

240 VAC

Figure 1-3

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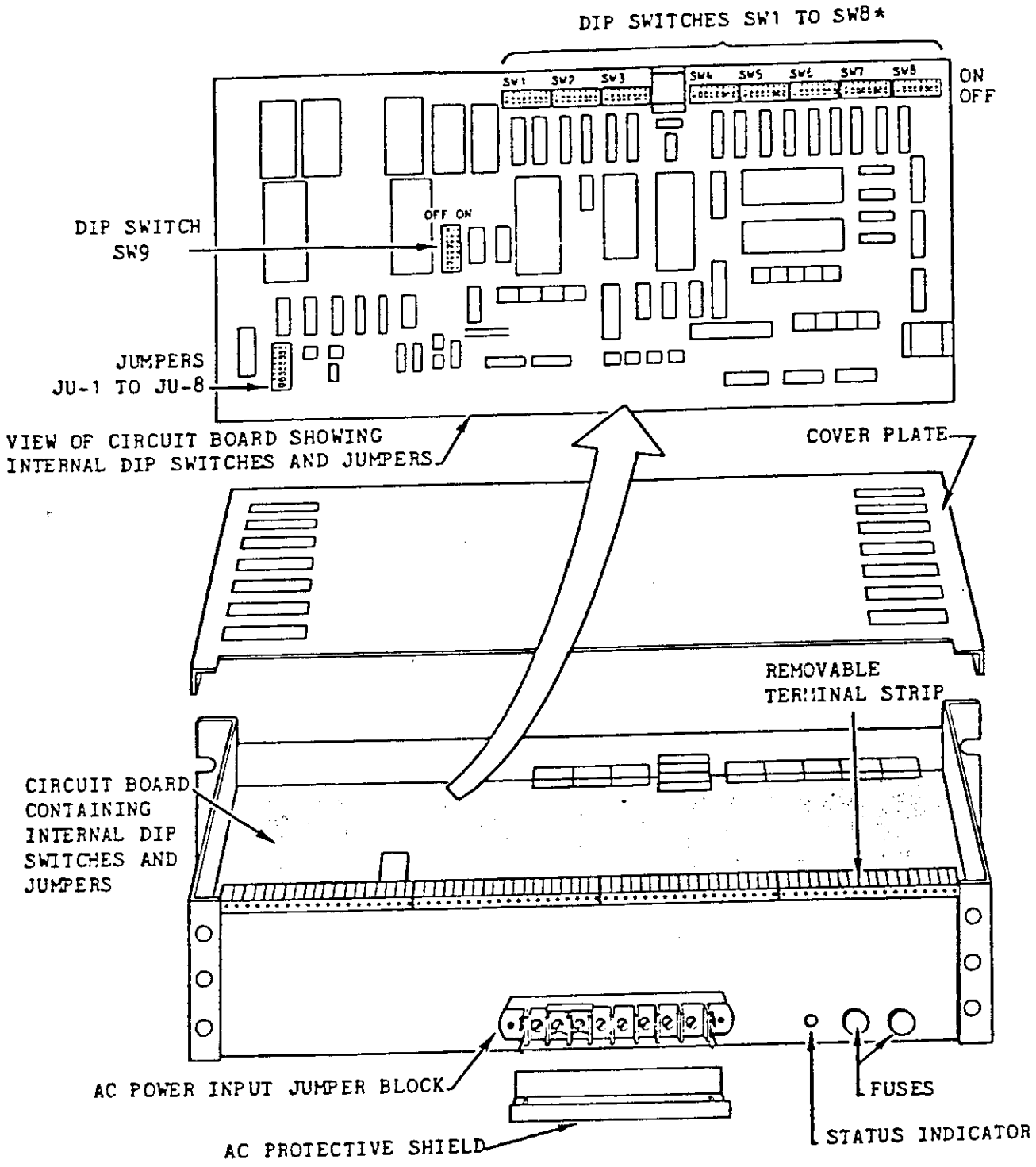


Figure 1-4

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Table 3-1. Model 430 Factory DIP Switch and Jumper Settings

DIP Switch	Setting	DIP Switch	Setting	DIP Switch	Setting
SW1-1	ON	SW5-1	OFF	SW9-1	OFF
SW1-2	OFF	SW5-2	OFF	SW9-2	OFF
SW1-3	OFF	SW5-3	OFF	SW9-3	OFF
SW1-4	OFF	SW5-4	OFF	SW9-4	OFF
SW1-5	OFF	SW5-5	OFF	SW9-5	ON
SW1-6	OFF	SW5-6	OFF	SW9-6	ON
SW1-7	OFF	SW5-7	OFF	SW9-7	OFF
SW1-8	OFF	SW5-8	OFF	SW9-8	OFF
SW2-1	OFF	SW6-1	OFF	JU-1	OFF
SW2-2	OFF	SW6-2	OFF	JU-2	OFF
SW2-3	OFF	SW6-3	OFF	JU-3	OFF
SW2-4	OFF	SW6-4	OFF	JU-4	OFF
SW2-5	OFF	SW6-5	OFF	JU-5	OFF
SW2-6	OFF	SW6-6	OFF	JU-6	OFF
SW2-7	OFF	SW6-7	OFF	JU-7	OFF
SW2-8	ON	SW6-8	OFF	JU-8	OFF
SW3-1	OFF	SW7-1	ON		
SW3-2	OFF	SW7-2	OFF		
SW3-3	OFF	SW7-3	ON		
SW3-4	OFF	SW7-4	OFF		
SW3-5	ON	SW7-5	OFF		
SW3-6	OFF	SW7-6	ON		
SW3-7	ON	SW7-7	OFF		
SW3-8	OFF	SW7-8	OFF		
SW4-1	ON	SW8-1	OFF		
SW4-2	OFF	SW8-2	OFF		
SW4-3	ON	SW8-3	OFF		
SW4-4	OFF	SW8-4	OFF		
SW4-5	OFF	SW8-5	OFF		
SW4-6	ON	SW8-6	OFF		
SW4-7	OFF	SW8-7	OFF		
SW4-8	OFF	SW8-8	OFF		

Figure 1-5

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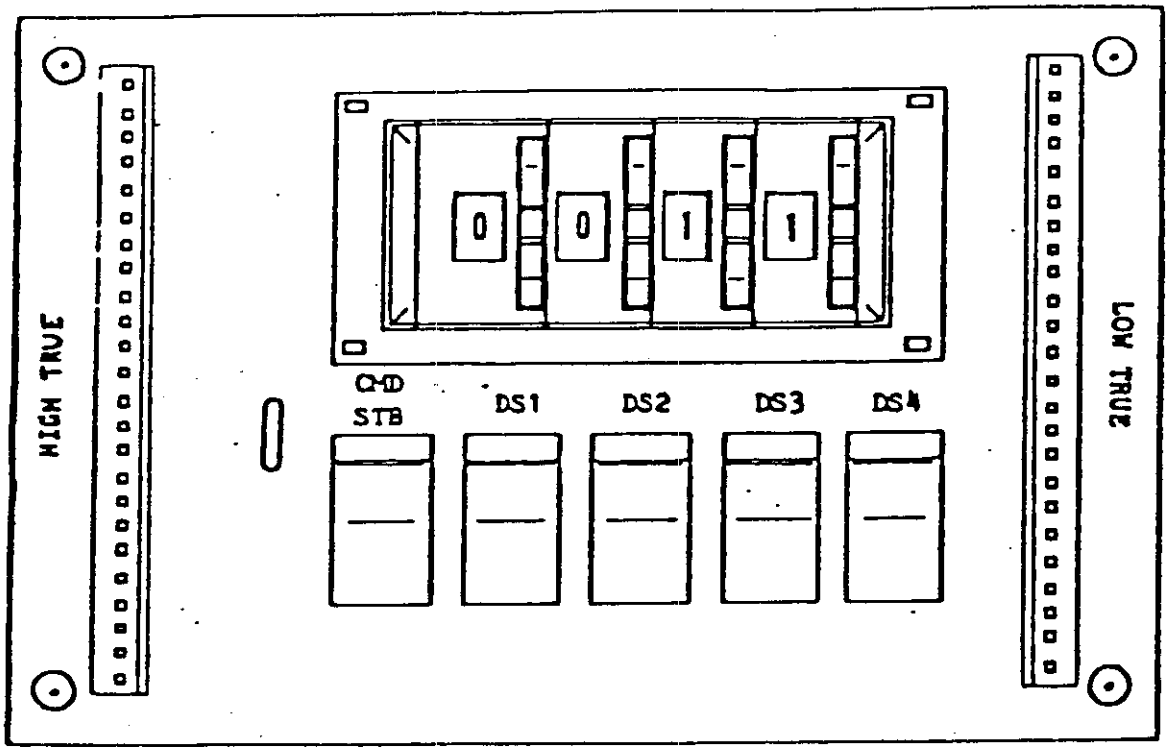


Figure 1-6

431 PROGRAMMER FUNCTIONAL TEST
431 Setting:9999

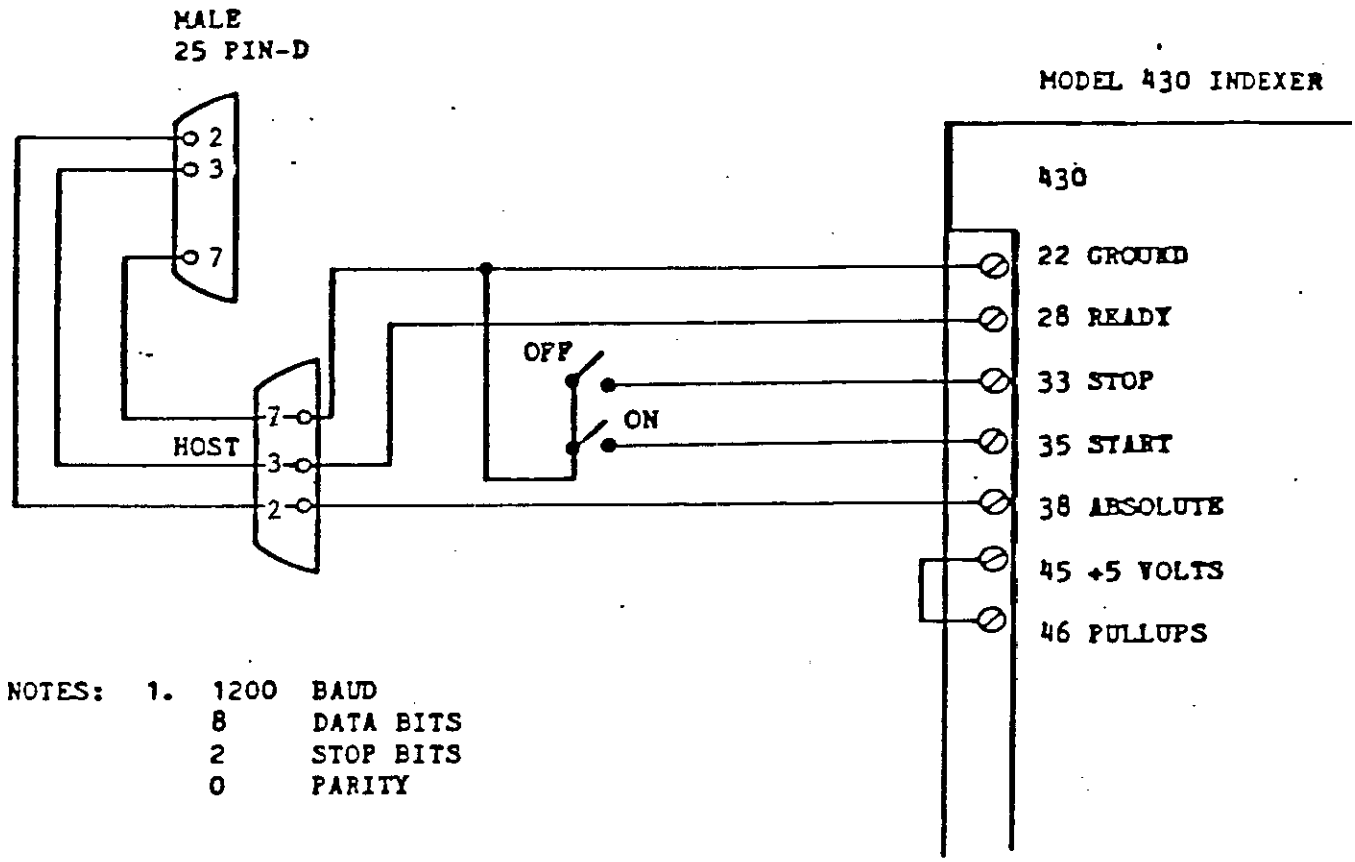
BITS:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VOLTAGES:	5	0	0	5	5	0	0	5	5	0	0	5	5	0	0	5

431 Setting:6666

BITS:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VOLTAGES:	0	5	5	0	0	5	5	0	0	5	5	0	0	5	5	0

Figure 1-7

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NOTES: 1. 1200 BAUD
8 DATA BITS
2 STOP BITS
0 PARITY

2. ABSOLUTE AND READY MAY NEED TO BE SWITCHED

Figure 1-8

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430 COMMAND ALPHABETICAL LISTING

Command	Table	Section	Page
[0000] NULL COMMAND	6-7	6.10.1	6-62
[0011] TURN ON AN OUTPUT	6-7	6.10.2.1	6-63
[0012] TURN OFF AN OUTPUT	6-7	6.10.2.2	6-63
[0013] TURN ON/OFF BOTH OUTPUTS	6-7	6.10.2.3	6-63
[0015] TURN ON/OFF OUTPUT ON CONDITION	6-7	6.1.2.4	6-64
[0018] TURN ON REMOTE POWER SHUTDOWN	6-6	6.10.3.1	6-66
[0019] SELECT REMOTE SHUTDOWN INPUT	6-7	6.10.3.2	6-66
[0020] SET MOVE DIRECTION	6-1	6.4.1	6-43
[0024] ENABLE POSITION MAINTENANCE	6-7	6.8.1	6-43
[0025] ENABLE MOVE TERMINATION ON STALL DETECT	6-5	6.8.2	6-46
[0032] EXECUTE LOOP	6-3	6.6.1.1	6-28
[0033] EXECUTE LOOP UNTIL CONTINUE	6-3	6.6.1.2	6-30
[0040] WAIT FOR CONTINUE	6-4	6.7.1.1	6-36
[0041] WAIT N MILLISECONDS	6-4	6.7.1.2	6-36
[0042] WAIT N SECONDS	6-4	6.7.1.3	6-36
[0043] WAIT N MINUTES	6-4	6.7.1.4	6-37
[0044] WAIT FOR A TRIGGER	6-4	6.7.1.5	6-37
[0046] SET OFFSET FROM ZERO	6-2	6.5.1	6-23
[0047] SET CLOSED LOOP OFFSET FROM ZERO	6-5	6.8.3	6-48
[0048] SET THE PRESENT POSITION AS ABSOLUTE ZERO	6-2	6.5.2	6-24
[0050] EXECUTE CONTINUOUS MOVE	6-3	6.6.2.1	6-30
[0051] EXECUTE PERFORM AN INCREMENTAL MOVE	6-3	6.6.2.2	6-31
[0052] EXECUTE PERFORM AN ABSOLUTE MOVE	6-3	6.6.2.3	6-31
[0053] EXECUTE CLOSED-LOOP INCREMENTAL MOVE } (in encoder units)	6-5	6.8.4	6-45
[0054] EXECUTE CLOSED-LOOP ABSOLUTE MOVE } (in encoder units)	6-5	6.8.5	6-46
[0056] DEFINE HOME	6-2	6.5.3	6-24
[0057] EXECUTE GO HOME	6-3	6.6.3.1	6-32
[0058] EXECUTE GO HOME CLOSED LOOP	6-5	6.8.6	6-46
[0064] EXECUTE A PREDEFINED MOVE	6-3	6.6.3.2	6-33
[0065] EXECUTE A PREDEFINED SEQUENCE	6-3	6.6.3.3	6-33
[0072] CONTINUE	6-3	6.6.4.1	6-34
[0112] STOP MOTION	6-4	6.7.2.1	6-40
[0114] SUSPEND THE SEQUENCE; WAIT FOR CONTINUE	6-4	6.7.1.6	6-38
[0116] STOP MOTION ON TRIGGER 1	6-4	6.7.2.2	6-41
[0118] SUSPEND THE SEQUENCE ON TRIGGER 1; WAIT FOR CONTINUE	6-4	6.7.1.7	6-38
[0120] KILL MOTION	6-4	6.7.2.3	6-43
[0124] KILL MOTION ON TRIGGER 1	6-4	6.7.2.4	6-42
[0176] DEFINE THE RATIO OF MOTOR STEPS TO ENCODER STEPS	6-5	6.8.8	6-48
[0177] DEFINE MOTOR RESOLUTION	6-5	6.8.9	6-49
[0178] DEFINE BACKLASH DEADBAND	6-5	6.8.10	6-50
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Compumotor

Operator's Manual

ADDENDUM: 430 NEW COMMANDS
P/N: 88-006140-02

Parker Hannifin Corporation
Compumotor Division
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Supplement to

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Operator's Manual:

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6.10.7 LIST SETUP PARAMETERS [0312] (DOMINANT)

This command operates in the same fashion as the LIST PROGRAM (0311) command. When this command is issued via RS-232, the indexer will report the setup parameters currently in working memory. Setup parameters are those resident in 430 working memory that are not reported by the List Program command. These include such things as the current velocity and Acceleration, Jog velocity, encoder resolution, and other functions listed below.

All of these parameters may be modified by commands received by the indexer. The output listing provided by the [0312] command reflects the current state of the setup parameters. The default state of the parameters is reported only if they have not been altered by command since the last reset. The output listing does reflect any setup commands that are invoked by the AUTO-RECALL function if it is active.

The 430 default response to teh 312 command is listed below. Some of the default parameters listed are read from teh internal configuration switches, some are stored in permanent memory. Each (except BCD input polarity) may be altered by the command whose number is lsited at the right. A comment on each parameter appears afterward, by number.

312 Command Output	Parameter Status	Associated Command number
1 INPUT LEVEL	LO	(switch)
2 POWER UP LOAD	OFF	(0293)
3 REM SHUT DOWN	ON	(0019)
4 REM DIRECTION	CW	(0020)
5 POS MAINT GAIN	1	(0179)
6 POS MAINT ALG	2	(0179)
7 MAX CORR VEL	2048	(0179)
8 POSITION MAINT	OFF	(0024)
9 STOP ON STALL	OFF	(0025)
10 AUTO BOOST	OFF	(0317)
11 BOOST TIME MS	0	(0029)
12 OUT 1 FUNCTION	0	(0015)
13 OUT 2 FUNCTION	0	(0015)
14 START_STOP VEL	0	(0214)
15 MOTOR RES TO	25	(0176)
16 ENC RES RATIO	4	(0176)
17 BACK LASH	0	(0178)
18 ROTOR TEETH	50	(0180)
19 MOTOR RESOLUTION	25000	(0177)
20 DEAD BAND	0	(0181)
21 SPEC REG DATA	0000 0000 0000 0000	(0301)
22 SPEC COMMAND	0065	(0301)
23 SPEC REG. NO	1	(0301)
24 HOME DEF.	YES LO CW 1 CW	(0056)
25 JOG PARAMETERS	1 25000 0 2147483647	(0281,0282)
26 GO HOME PARAM.	0 500000 0 500000	(0261,0262)
27 CURRENT V & A	0 500000 0 500000	(0261,0262)

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1. INPUT LEVEL
This parameter reflects the state of internal Dipswitch S5-4 which controls the polarity of the BCD data inputs. HI means high true, LO is low true (0 volts = logic 1). See Section 3.7.10

2. POWER UP LOAD
This parameter indicates whether the program AUTORECALL function is enabled (ON/OFF). See Section 6.9.5

3. REM SHUTDOWN
This parameter indicates which Shutdown command source is enabled. "ON" indicates that the Shutdown input (termin2al 32) is enabled, otherwise the Shutdown command [0018] has control. See Section 6.10.3

4. REM DIRECTION
This parameter indicates whether or not the Direction output polarity has been reversed with command [0020]. A Positive absolute position implies a position clockwise (CW) from the zero position unless this parameter indicates CCW. See Section 6.4.1

5. POS MAINT GAIN
This parameter indicates the current Position servo loop gain. See Section 6.8.11.

6. POS MAINT ALG
This parameter indicates which servo algorithm is used to calculate position correction velocity. See Section 6.8.11.

7. MAX CORR VEL
This parameter determines the maximum limit on position correction velocity. The actual velocity depends on what velocity range is specified in command [0179], in that the velocity units may range from steps per second to steps per 1000 seconds. The default range is 1, units are steps per 10 seconds, and the velocity specified above is equivalent to 204.8 steps/sec. See Section 6.8.11.

8. POSITION MAINT
This parameter indicates whether or not the Position Maintenance servo function is currently active. (OFF/ON) See Section 6.8.1.

9. STOP ON STALL
This parameter indicates whether or not the Stall detection function is currently active. (OFF/ON) See Section 6.8.2.

10.AUTO BOOST
This parameter indicates whether or not the BOOST on Acceleration function is currently active. (OFF/ON) See Section 6.10.8.

11. BOOST TIME MS
This parameter indicates the duration in milliseconds of the Automatic BOOST signal after the motor comes to a stop. See

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Section 6.10.8.

12. OUT 1 FUNCTION
This parameter indicates whether or not OUT 1 has been assigned to indicate some aspect of indexer function. See Section 6.1.2

13. OUT 2 FUNCTION
This parameter indicates whether or not OUT 2 has been assigned to indicate some aspect of indexer function. See Section 6.1.2

14. START_STOP VEL
This parameter reflects the current setting of the Start/Stop velocity. See Section 6.4.2.

15. MOTOR RES TO
This parameter and the following one indicate the motor to encoder resolution ratio, used by all closed-loop instructions. See Section 6.8.8

16. ENC RES RATIO
This parameter and the prior one indicate the motor to encoder resolution ratio, used by all closed-loop instructions. See Section 6.8.8

17. BACK LASH
This parameter indicates the setting for allowable backlash in the encoder response before the indexer determines that the motor has stalled. See Section 6.8.10

18. ROTOR TEETH
This parameter provides information on motor characteristics used to calculate the maximum possible position error before a Stall condition has occurred. (250 steps for a 50 tooth rotor on a 25,000 step motor) See Section 6.8.12

19. MOTOR RESOLUT.
This parameter indicates the motor resolution setting used in the above calculation to determine the maximum error in motor steps. See Section 6.8.12

20. DEAD BAND
This parameter indicates the user setting for allowable backlash in encoder response before the indexer gives a signal. The signal function must be established using command [0015]. See Section 6.1.2

21. SPEC REG DATA
This parameter indicates the Register data assigned to the SPECIAL input command used when the 430 responds to the SPECIAL input. See Section 6.10.5

22. SPEC COMMAND
This parameter indicates the number of the command executed

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when the 430 responds to the SPECIAL input. See Section 6.10.5

23. SPEC REG. NO.
This parameter indicates the target Register for the data to be read from the BCD inputs when the 430 responds to the SPECIAL input. (1, 2, 3, or 4) See Section 6.10.5

24. HOME DEF.
This parameter indicates five Home limit setup conditions in the following order:
(1) whether the HOME signal has been defined (YES/NO)
(2) the final HOME approach direction (CW/CCW)
(3) the polarity of the HOME signal (HI/LO)
(4) the final approach speed as a percentage of the GO HOME velocity
(5) which edge of the signal is desired (CW/CCW)
See Section 6.5.3

25. JOG PARAMETERS
This parameter indicates JOG function rates, including velocity range, velocity, acceleration range, and acceleration in that order. See Section 6.4

26. GO HOM PARAM.
This parameter indicates Homing function rates, including velocity range, velocity, acceleration range, and acceleration in that order. See Section 6.4

27. CURRENT V & A
This parameter indicates the current rates for subsequent defined moves or the default move, including velocity range, velocity, acceleration range, and acceleration in that order. See Section 6.4

6.10.8 RESET [0084] IMMEDIATE

This command duplicates the function of the RESET input (terminal 24). The 430 responds by setting all outputs to their Off state, erasing any program in working memory, and either restoring default setup parameters, or loading the program in non-volatile memory if AUTORECALL (0293 command) is enabled.

6.10.9 PURGE MEMORY [0256] IMMEDIATE

This command has the effect of restoring the 430 to its primary default condition. Both working memory and non-volatile memory are erased. Executing this command is essentially equivalent to shutting off AUTORECALL (0293 command), Resetting the 430 (0084 command) and executing the SAVE instruction (0291 command) to save nothing thereby erasing non-volatile memory. Default parameters will be restored.

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Chapter 1

INTRODUCTION

1.1 OVERVIEW

The Compumotor 430 Indexer* (Figure 1-1) is designed for industrial applications in electrically noisy environments. The 430 will interface with most parallel-interface programmable controllers and commercially available computers. The 430 can also be set up for use with RS-232C compatible devices, with discrete input devices such as simple switches and BCD thumbwheels, and with a combination of discrete devices and programmable controllers or computers. The 430 can be operated manually using a small number of discrete inputs or can be controlled by a programmable controller or by a computer.

The 430 will drive any size Compumotor motor/drive set or standard 200/400-step translator and stepper motor combinations. Depending on the particular Compumotor motor/drive used, a single revolution can be subdivided into 1,000, 4,096, 21,600, 25,000, 25,400, 36,000, or 50,000 individual steps. Using the Indexer, you can rotate the motor shaft to a precise position and stop; or rotate at a constant velocity; or alternately move back and forth between two angular positions; or use a combination of such moves.

The 430 is normally used for precise position control with no external position feedback. An operating mode (Position Tracking) is available for closed-loop operation to further enhance the accuracy of position control and increase the "stiffness" of the motor.

A combination of successive positions, motions, accelerations, decelerations, and rotational velocities can be preprogrammed. The 430 commands are described in detail in Chapter 6.

*Referred to as "430" or "Indexer" throughout this manual.

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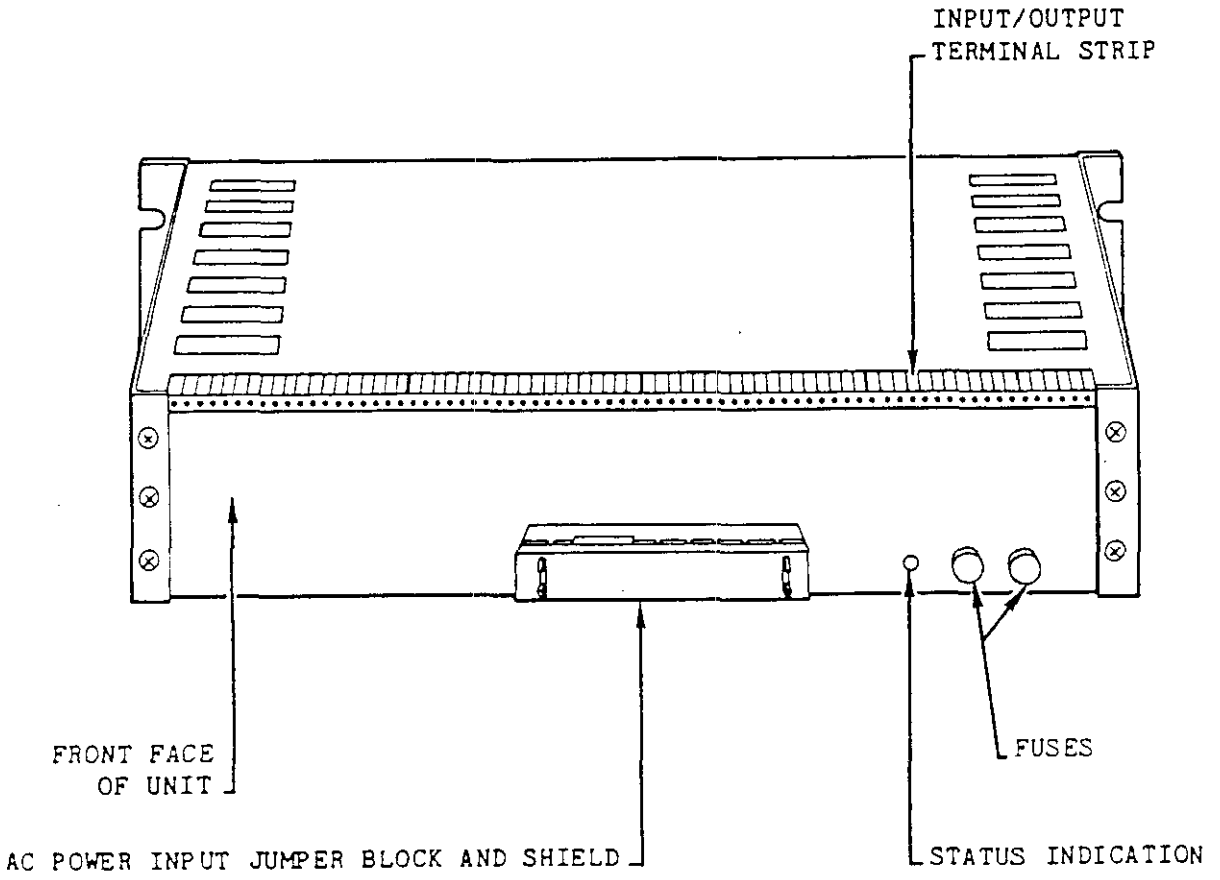


Figure 1-1. Model 430 Indexer

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Note

The Compumotor Driver and the Compumotor Motor, which are a matched pair, are referred to as the motor/drive in this manual.

You do not have to be an expert in any field to use the 430 Indexer. This manual contains all information you will need to install and successfully operate the 430. If a terminal or computer is intended to control the 430, you will need access to the computer or terminal manuals that define setup conditions for RS-232C operation of the respective terminal or computer. This manual assumes that you have access to the applicable equipment manuals.

1.2 GENERAL DESCRIPTION

The Model 430 Indexer, which is a 16-bit, microprocessor-based, programmable pulse generator, is specifically designed for industrial applications in noisy electrical environments. The unit is mounted in a rugged enclosure. All connections and indicators are on the face of the unit. A terminal strip provides screw-terminal interconnects. All command and signal lines are optically isolated to ensure proper operation in an electrically noisy environment.

The Indexer can be controlled:

a. As a single input (**START**) device that executes a simple move based on internal switch settings.

b. As a preprogrammed device controlled by a small number of control inputs either manually with a control panel or automatically by a programmable controller.

c. As part of a real-time system controlled by a programmable controller or computer.

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1.2.1 SINGLE INPUT OPERATION

The parameters for a single move that does not use the 430's preprogramming capability can be set up with internal switches. (See section 3.7.) Each time the **START** input (Terminal 35) is connected to signal ground, the Indexer will drive the motor/driver, and the single move will be executed. In this mode the single move is executed each time the **START** is connected to signal ground. Single input operation is well suited for a single-move pattern that is used for relatively long periods of time for a given application.

1.2.2 MULTIPLE PREPROGRAMMED MOVES

The Indexer includes a permanent memory that will store 40 predefined move commands. A move command consists of a mode, acceleration, velocity, direction, and distance parameter. Multiple preprogrammed moves are useful in situations where more than one move pattern is required for a given application.

The Indexer can be preprogrammed for 40 moves and 15 sequences. Different input lines (see section 3.6) are used to select preprogrammed moves and sequences. (A sequence consists of a combination of moves and other commands such as loops and time delays.) Manual control via a control panel or automatic control via a programmable controller can be used to select the moves and sequences at appropriate times or points in a process.

The Indexer can be programmed manually via a control panel, via a serial input line with a terminal or computer, or via the parallel command interface using a programmable controller.

In many industrial environments, where setups are frequently changed, the most practical approach may be to use a computer or terminal to preprogram the unit and a programmable controller for extended floor operations.

If the preprogrammed moves and sequences are relatively simple, manual preprogramming via a terminal on the Model 431 Panel (section 1.3) may be appropriate. The trade-off between manual and computer programming is one of labor and down-time vs purchase and use of a small computer.

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1.2.3 REAL TIME SYSTEMS

A real-time system, responsive to process conditions, can be configured using a combination of the 430, a programmable controller, and process sensors.

1.3 OPTIONAL FEATURES

A Model 431 Manual Programming Unit is available to manually program the 430 Indexer (see Figure 1-2). This unit consists of four BCD thumbwheel switches and five strobe switches mounted on a circuit board plus associated cabling to connect to the Indexer parallel interface.

1.4 SPECIFICATIONS

Performance, electrical, environmental and mechanical specifications are presented in Tables 1-1 and 1-2. Input and output specifications are summarized in Tables 3-2 and 3-3.

1.5 TECHNICAL ASSISTANCE

If you need Technical Assistance, please contact:

Customer Service Department
Compumotor Corporation
1179 North McDowell Boulevard
Petaluma, CA 94952
(707) 778-1244

Do not ship the unit to the factory for service until you have been given an authorization number by the factory.

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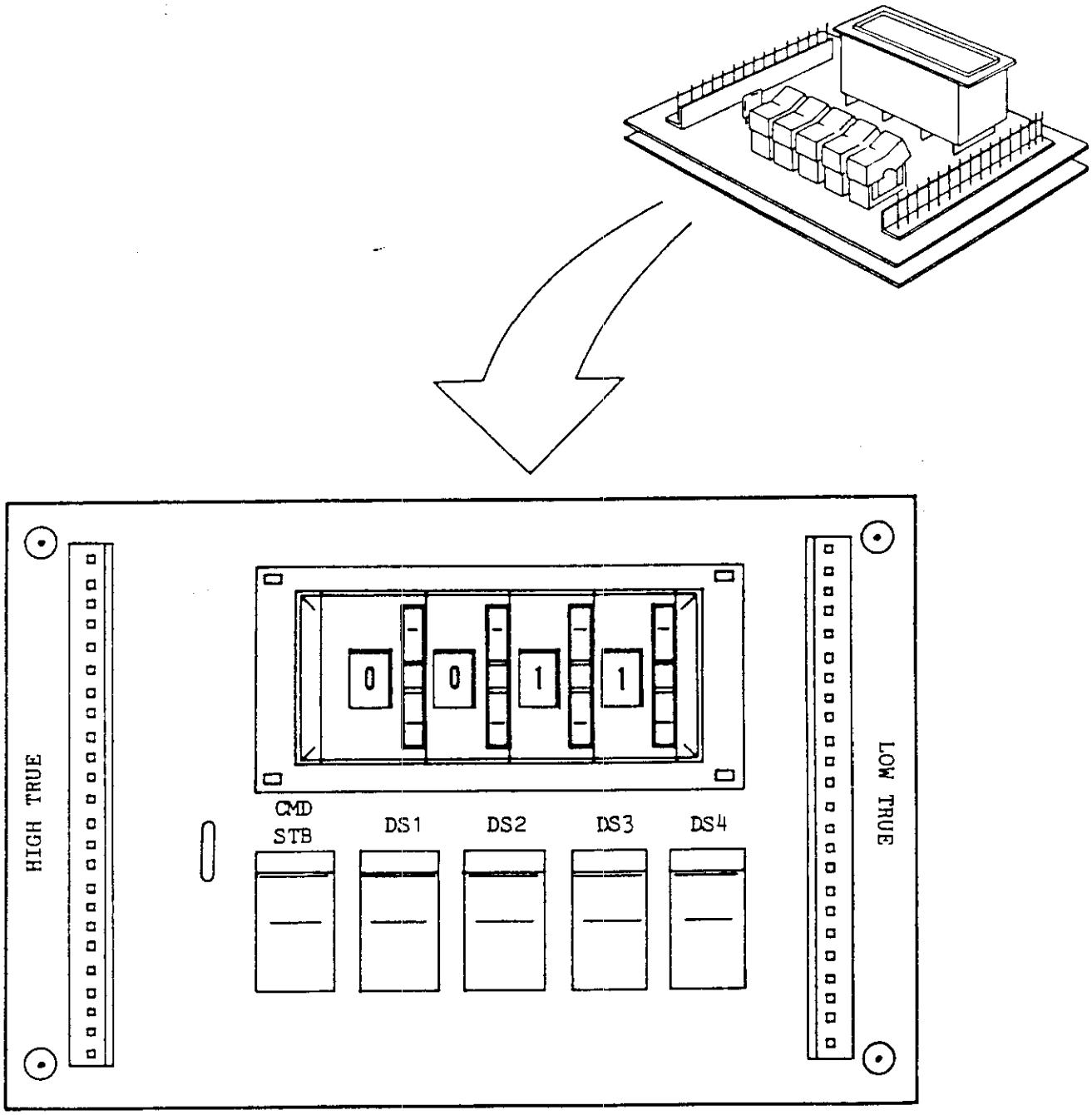


Figure 1-2. Model 431 Input Panel

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Table 1-1. 430 Series Performance and Electrical Specifications

Parameter	Value
Performance:	
Stepping Accuracy	±0 Steps from Preset total
Velocity Accuracy	±0.02% of Set rate
Velocity Repeatability	±0.02% of Set rate
Power:	Single Phase
Frequency	(50/60 Hertz)
100-130 VAC input	0.8 Amps maximum
220-240 VAC input	0.4 Amps maximum

Table 1-2. 430 Series Mechanical and Environmental Specifications

Parameter	Value
Size:	
Height	7.28 in. (18.49 cm)
Width	3.05 in. (7.75 cm)
Length	16.04 in. (40.74 cm)
Weight Pounds (Kg)	Net 10 (4.5) Shipping 15 (6.8)
Operating Temperature	32 to 140°F (0 to 60°C) 0 to 95% Humidity, non-condensing
Storage Temperature	-22 to 185°F (-30 to 85°C)

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Chapter 2

BASIC SYSTEM CONCEPTS

2.1 GENERAL

All Indexer/Indexer System applications involve either rotation of a Compumotor motor shaft to a precise angular position (number of steps) or rotation of the motor shaft at a prescribed angular velocity (revolutions per second). In most models the Indexer, Motor, and motor/drives are separate assemblies. In some of the models the Indexer and Driver are combined into one assembly.

A technique known as microstepping, which is described in detail the Compumotor Product Catalog, is used to obtain high-resolution rotary motion. A standard translator/stepper motor can be stepped in equal increments of 200 or 400 steps per revolution (steps/rev), making each step equivalent to 1.8 or 0.9 degrees. Microstepping permits as many as 50,000 steps/rev, depending on the design of the motor/drive. You can choose from Compumotor motor/drive options ranging from 1,000 to 50,000 steps/rev for your application. Both the size and the resolution of the Compumotor motor/drive must be determined for any given application. Refer to the Compumotor Product Catalog for a discussion of motor characteristics, torque calculations, and selection criteria.

Each time the Compumotor motor/drive receives one step pulse, it rotates the motor one angular increment. You may choose to control either angular position or angular velocity with a high degree of precision without any external feedback.

When commands are structured for the system, it is necessary to think in terms of the number of steps/rev; e.g., for a 25,000-step motor, 180 degrees = 12,500 steps, 1 revolution = 25,000 steps, etc. You must refer the desired load motion for your application to rotation of the Compumotor motor shaft. Shaft motion is specified in terms of acceleration, angular velocity, and angular position.

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2.2 ACCELERATION/VELOCITY PROFILES

The motor moves in incremental steps. In practical applications, load inertia tends to smooth the actual load motion. The small size of the motor steps minimizes end-of-move settling time at moderate acceleration values.

2.2.1 ACCELERATION/DECELERATION

Acceleration/deceleration is defined as the rate of increase/decrease of angular velocity in steps, or revolutions per second per second (rev/sec/sec). When the Indexer drives the motor from rest to a given velocity, a string of pulses is sent to the motor/drive.

Relatively high pulse rates are used to drive the high-resolution Compumotor Motors; therefore, the shaft velocity buildup can be graphically portrayed by a straight line, as shown in Figure 2-1.

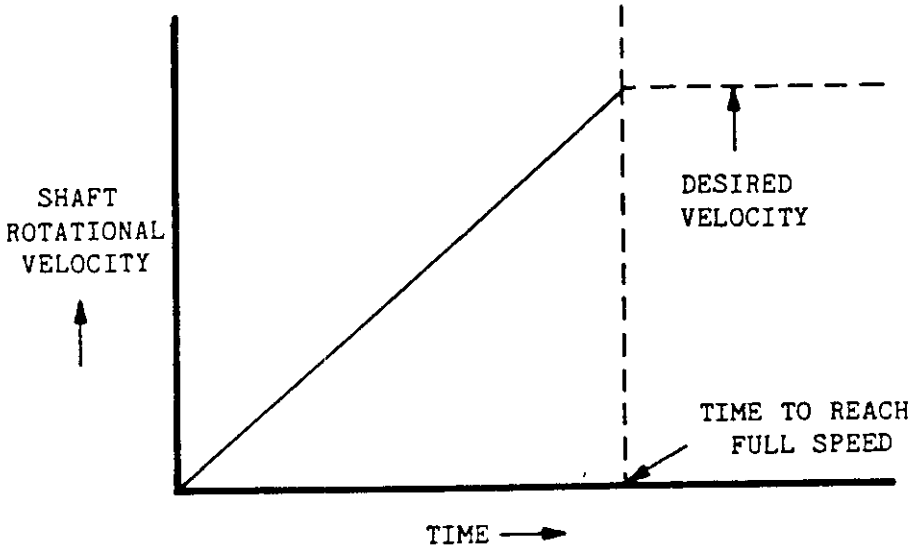
The acceleration/deceleration rate must be selected as a function of the inertia of the load to allow operation within the torque limits of the motor. A margin of 50 to 100 percent of normal load torque requirements is recommended. If the selected acceleration rate requires torques that exceed the capability of the Compumotor motor/driver, the motor will stall without any damage to it.

The acceleration/deceleration rate can be varied between broad limits. When very high acceleration rates are used, there may be a tendency for overshoot and longer setting times. Normally the acceleration and deceleration rates are equal.

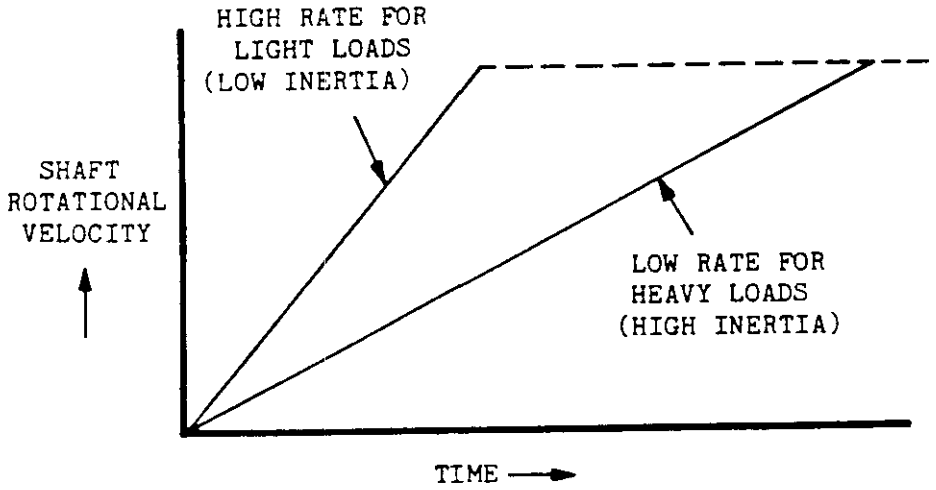
2.2.2 MOTION PROFILES

Refer to Figure 2-2. The trapezoidal motion pattern (Figure 2-2A) will occur when the angular distance to be covered is large compared with the angular distance required to reach the specified angular velocity. Part of the motion occurs at a constant velocity. An example is a move in which one-fourth of the move time is acceleration, one-half of the time velocity

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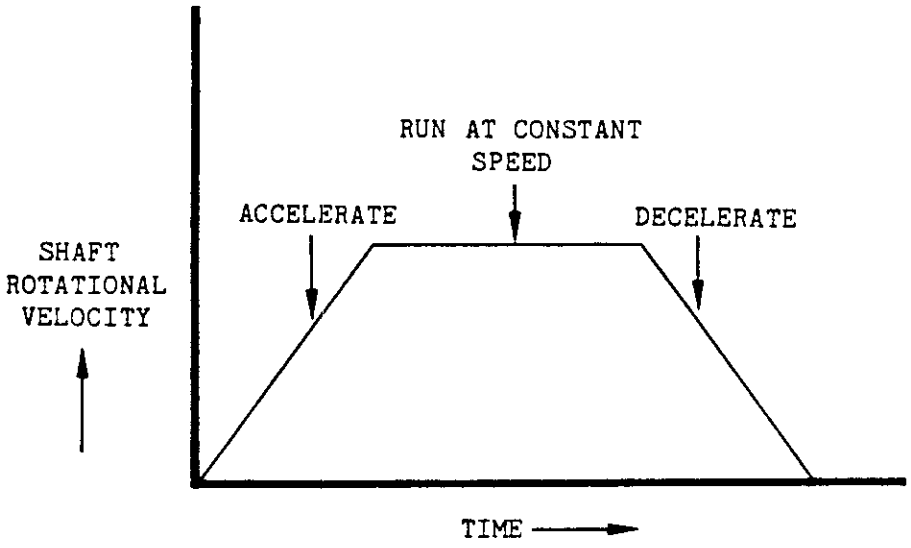
A. ACCELERATION CURVE



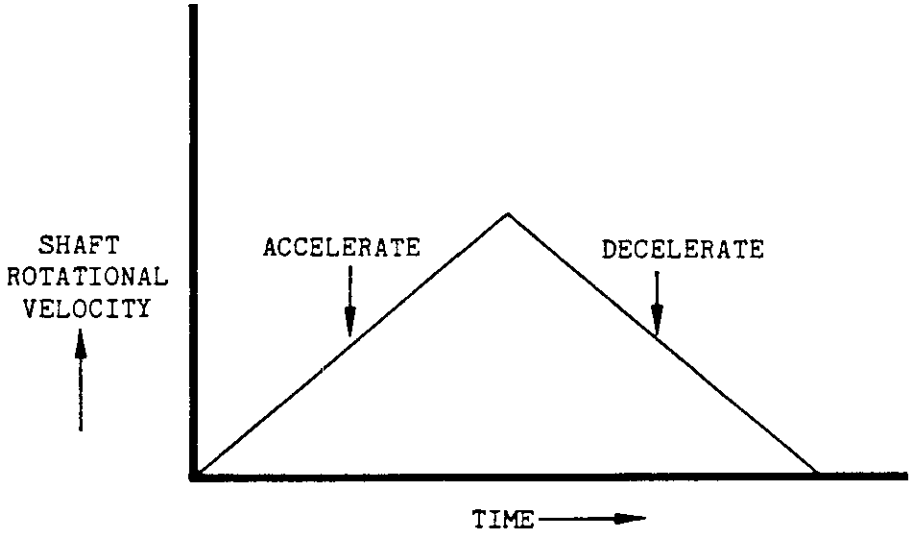
B. INDEXER CAPABILITY

Figure 2-1. Velocity Buildup

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A. TRAPEZOIDAL MOTION PATTERN



B. TRIANGULAR MOTION PATTERN

Figure 2-2. Motion Profiles

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is constant, and one-fourth of the time is deceleration. The triangular motion pattern (Figure 2-2B) occurs when the angular distance required to reach the specified velocity is large compared to the angular distance to the new position. In this case the motor shaft velocity continually changes during the move, and there is no constant velocity phase. The average velocity would be one-half the peak velocity.

2.3 MOTOR RESOLUTION, VELOCITY RANGE, ACCELERATION RANGE, AND POSITION RESOLUTION

2.3.1 MOTOR RESOLUTION

Motor resolution is defined by the motor/drive used with the Indexer (Table 2-1).

Table 2-1. Resolution Per Step

Motor Resolution (steps/rev)	Equivalent Value Per Step	
	part of rev*	min of arc*
50,000	2.0000×10^{-5}	0.4320
36,000	2.7778×10^{-5}	0.6000
25,400	3.9370×10^{-5}	0.8504
25,000	4.0000×10^{-5}	0.8640
21,600	4.6296×10^{-5}	1.0000
4,096	2.4410×10^{-4}	5.2734
1,000	1.0000×10^{-3}	21.6000
400	2.5000×10^{-3}	54.0000
200	5.0000×10^{-3}	108.0000

*Rounded values

2.3.2 VELOCITY RANGE

Velocity ranges can be selected with internal DIP switches or via the command interface.

2.3.3 ACCELERATION/DECELERATION RANGE

The acceleration range can be selected with internal DIP switches or via the command interface. The basic considerations when selecting acceleration range are the torque capability of the motor, risk of load overshoot, and the physical characteristics of the mechanical transmission coupled to the motor/drive.

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2.4 ANALYSIS OF YOUR APPLICATIONS

The basic elements that are present in most applications are shown in Figure 2-3.

2.4.1 GENERAL CONSIDERATIONS

LIMIT SWITCHES

In all cases you must determine whether limit switches will be required to protect the load. (See Chapter 3 for limit switch installation instructions.)

ENCODERS

Determine if Encoder feedback is required. When you select Position Tracking, you have a number of choices, as follows:

a. You can mount the Encoder at the load and assure the proper positioning of the load despite any gear play or friction effects of the mechanical transmission between the motor and the load.

b. You can use a motor with the Encoder mounted on the motor shaft so that the motor will resist movement induced by externally applied torques.

c. You can use the Encoder as a stall detector to identify whether the motor has stalled.

d. You can use the Encoder to independently verify the load position.

DISCRETE INPUTS

Determine if the discrete inputs for **START**, **STOP**, **COUNTERCLOCKWISE LIMIT**, **CLOCKWISE LIMIT**, and **LOAD STOP** inputs are required.

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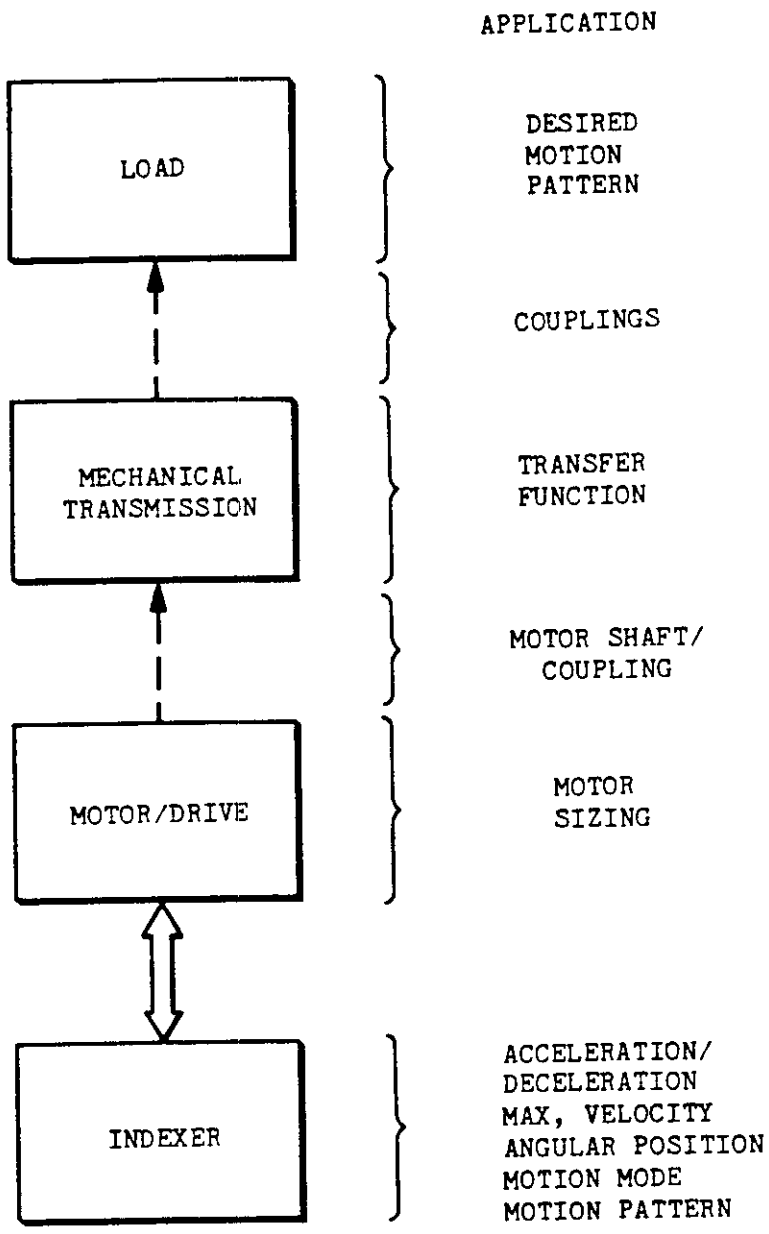


Figure 2-3. Basic Elements to Be Analyzed

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POSITION DEFINITION IN MOTOR STEPS

Determine the number of steps required to reach a desired angular position of the Compumotor motor shaft based on the angular resolution of your system.

MOTOR/DRIVE SIZING

The motor/drive must be sized for the application. Refer to the Compumotor Product Catalog for sizing guidelines.

2.4.2 RECOMMEND APPROACH FOR DEFINITION OF ACCELERATION AND VELOCITY

The desired load motion pattern must then be referenced to the Compumotor motor shaft. The motor/drive acts as a relatively stiff drive source. Theoretically you could use detailed mathematical analyses to determine the proper values of position, acceleration, and velocity. In addition to acceleration, velocity, and position, your analysis must include a definition of any gear play, coupling effects, transmission elasticity, load inertia, load friction, etc. In practical situations use of such detailed analytic techniques is not necessary and is frequently undesirable. Alternatively, you can approximate an initial set of position, acceleration, and velocity values. These approximations can then be tested in the actual application and revised as necessary.

The relationship of the acceleration/deceleration and velocity settings can be approximated by

$$a = (v_f - v_o)/t$$

$$a = 4.8\ d/t^2$$

$$v = 1.5\ d/t$$

Where d = number of steps
a = angular acceleration,
v_f = final angular velocity,
v_o = initial angular velocity
t = time.

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This equation can be used to approximate the desired parameter, the value of acceleration required, as shown in Figure 2-4, or the time to move, as shown in Figure 2-5.

A motor/drive will stall (without any damage) whenever the performance specified by a command exceeds the capability of the motor/drive being used. You can experimentally determine the actual velocity and acceleration values. You can set the Indexer to the set of approximate values and then adjust the values to achieve the desired performance.

2.5 EQUIPMENT CONFIGURATION ALTERNATIVES

2.5.1 SIMPLEST CONFIGURATION

The simplest configuration (Figure 2-6) consists of a basic Indexer and a Compumotor motor/drive connected to a load.

2.5.2 LIMIT SWITCHES

Limit switches can be installed on the load (which is recommended) and connected to the Indexer to protect the load from overtravel. This is shown in Figure 2-7. If they are not used, the limit switch inputs must be grounded.

2.5.3 POSITION TRACKING

Position Tracking can be used, with an incremental encoder, as shown in Figure 2-8, to

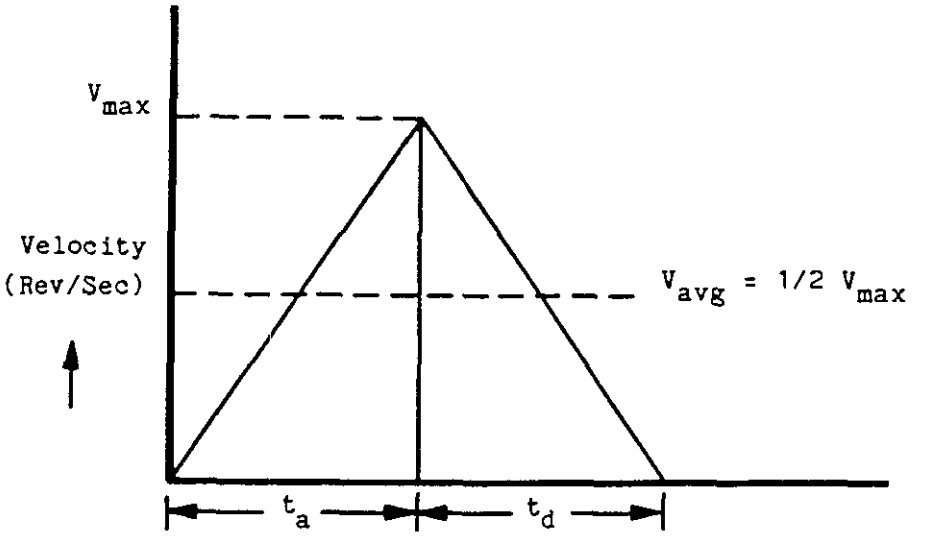
a. Provide encoder referenced positioning.

b. Independently verify position.

c. Compensate for external torques.

d. Detect motor stall.

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$$V = \frac{1.5d}{t} \qquad A = \frac{4.8d}{t^2}$$

Example:
Assume d total = 23,000 steps
t total = 2.75 seconds

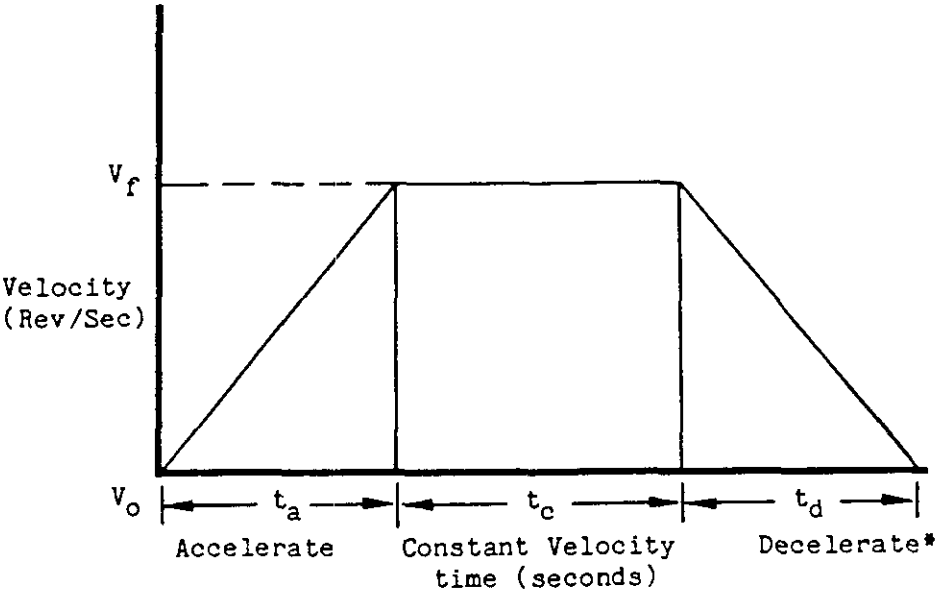
$$V_{avg} = \frac{23,000}{2.75} = 8363.63 \text{ steps/sec}$$

$$V_{max} = 2 \times 8363.63 = 16,727.27 \text{ steps/sec}$$

$$A = \frac{4.8(\frac{23,000}{2})}{(\frac{t^2}{2})} = 29,190.0 \text{ steps/sec/sec}$$

Figure 2-4. Velocity and Acceleration -- Triangular Move Profile

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*Generally, acceleration rate equals deceleration rate

$$t_a = \frac{V_f - V_o}{a}$$

$$t_c = \frac{d}{V_f}$$

$$t_d \text{ (match)} = \frac{V_f - V_o}{a}$$

a = acceleration (rev/sec/sec)

d = number revolutions or steps

V_f = rev/sec

a = Deceleration (rev/sec/sec)

Example (25,000 step motor):

a = Acceleration set to 10 rev/sec/sec (deceleration is same value)

V_f = Velocity set to 3.75 rev/sec

d = Distance set to 19.65 revolution

$t_a = \frac{V_t - V_o}{a} = \frac{3.75-0}{10} = 3.75$ seconds

V_{avg} = Average velocity in period t_a = 3.75/2 = 1.875

$t_a \times V_{avg}$ = 3.75 x 1.875 = 7.03125 revolution

$t_d = t_a$, therefore distance moved during deceleration equals 7.03125 revolution

d = Distance to be moved at constant velocity (V_f) equals

19.65-2(7.03.25) = 5. 875 revolutions

$t_c = d/V_f$ = 5.5875/3.75 = 1.49 seconds

time to move = 2 x 3.75 + 1.49 = 8.99 seconds

Figure 2-5. Time to Move -- Trapezoidal Move Profile

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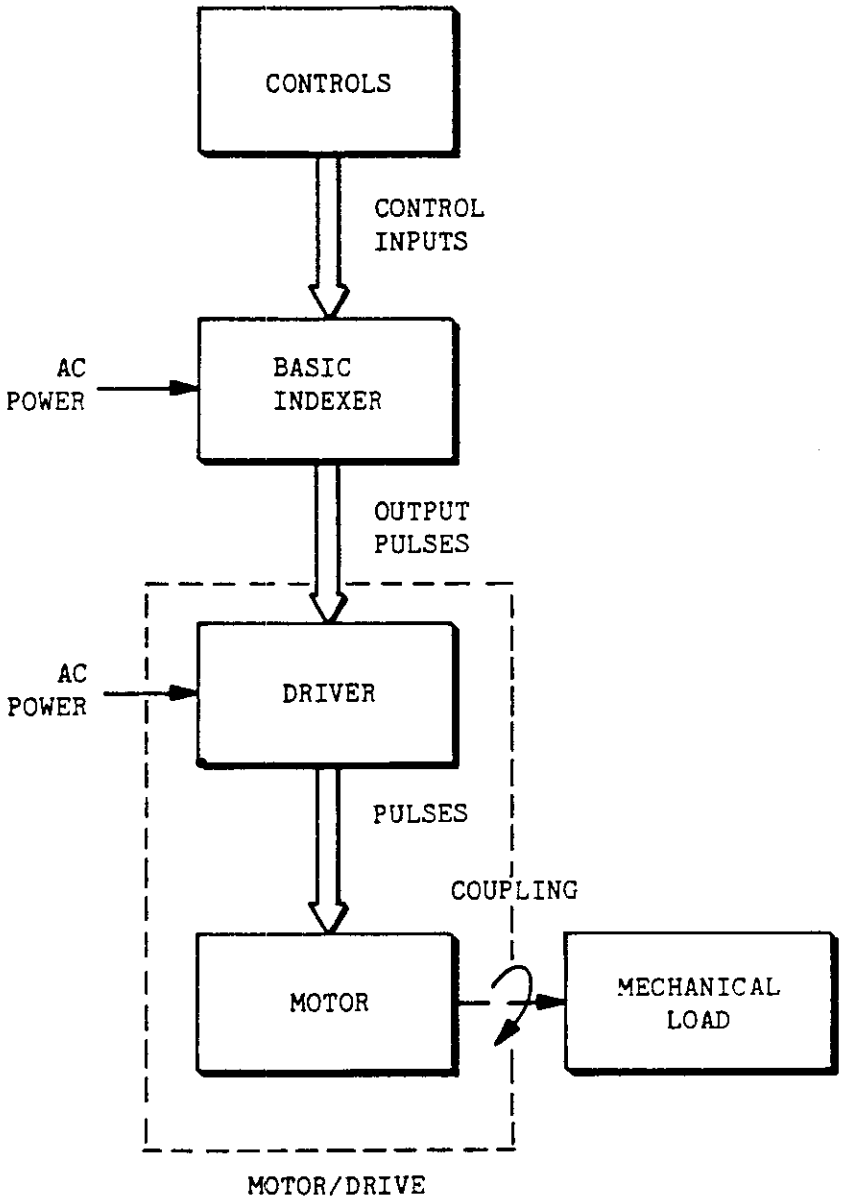


Figure 2-6. Simplest Configuration

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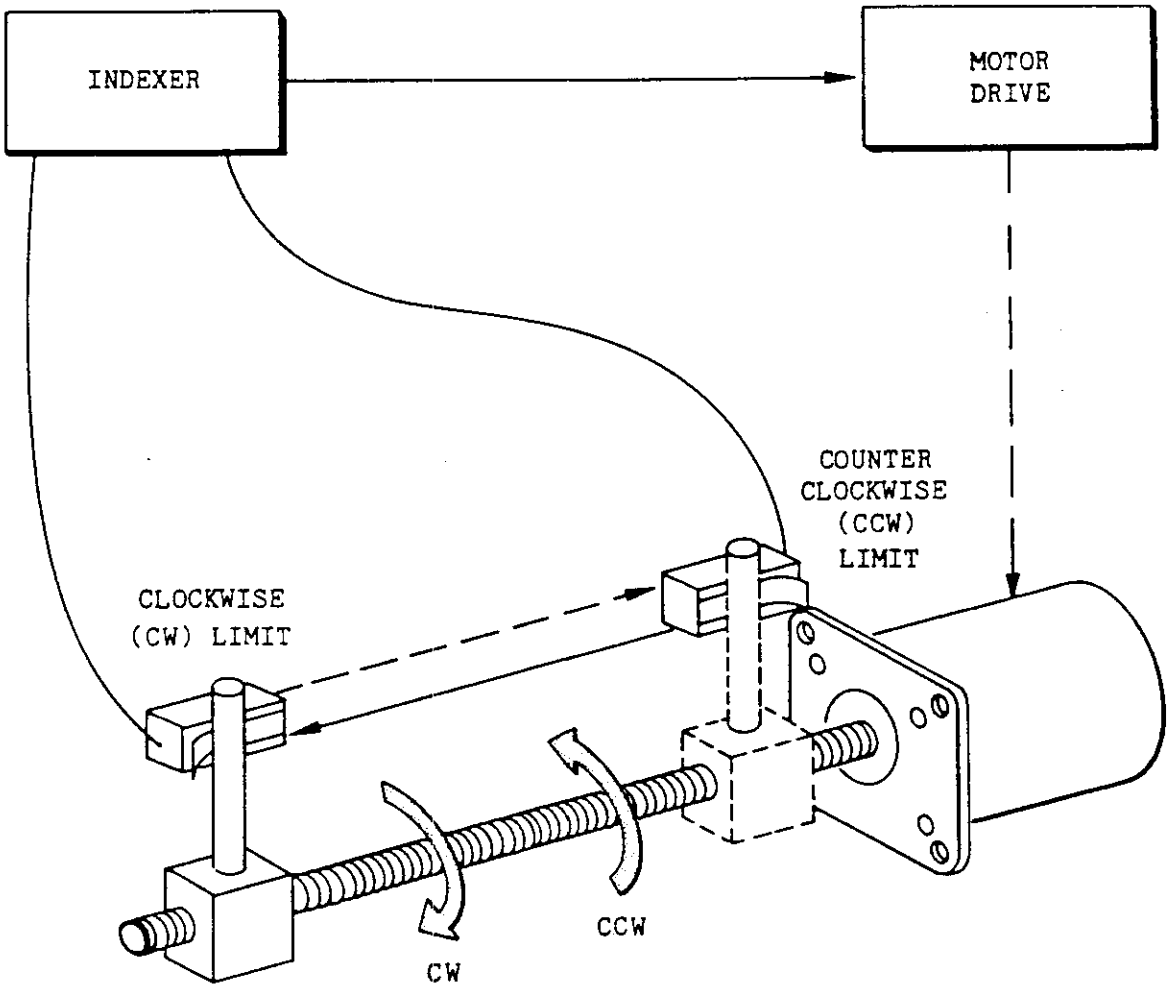


Figure 2-7. Limit Switch Input

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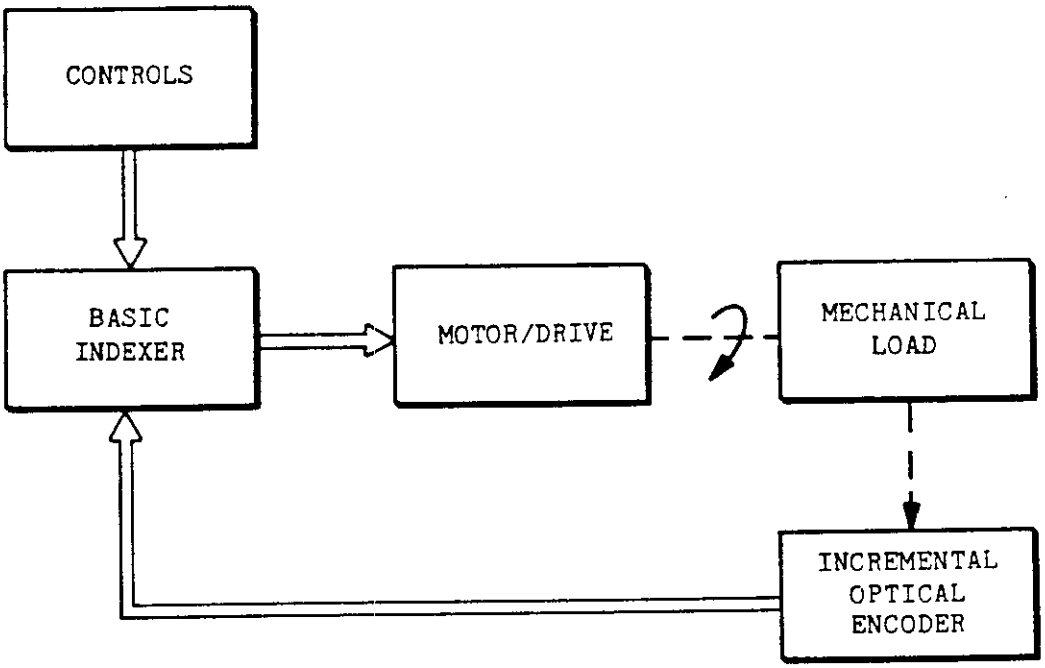


Figure 2-8. Addition of Position Tracking

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2.5.4 PROGRAMMABLE CONTROLLER OR COMPUTER-CONTROLLED OPERATION

A programmable controller or computer can be used for controlling the Indexer, as shown in Figure 2-9.

One advantage of this approach is that command messages can be stored and used repeatedly at different times. A number of programs can be stored and then recalled in response to load conditions. Operation can be automatic and interactive if the proper load sensors and process controllers are installed.

2.5.5 MULTIPLE FUNCTION ASSEMBLIES

Multiple function assemblies are also available. Some specific examples are:

a. Basic Indexer plus power supply plus driver is one package (DH Series).

b. Local control panel plus basic Indexer plus power supply plus Position Tracking plus IEEE-488 interfaces is one package (2100 Series)

c. Liquid crystal display control panel plus four basic Indexers plus power supply is one package (3000 Series).

Consult with your Compumotor representative to select the proper equipment models and options for your application.

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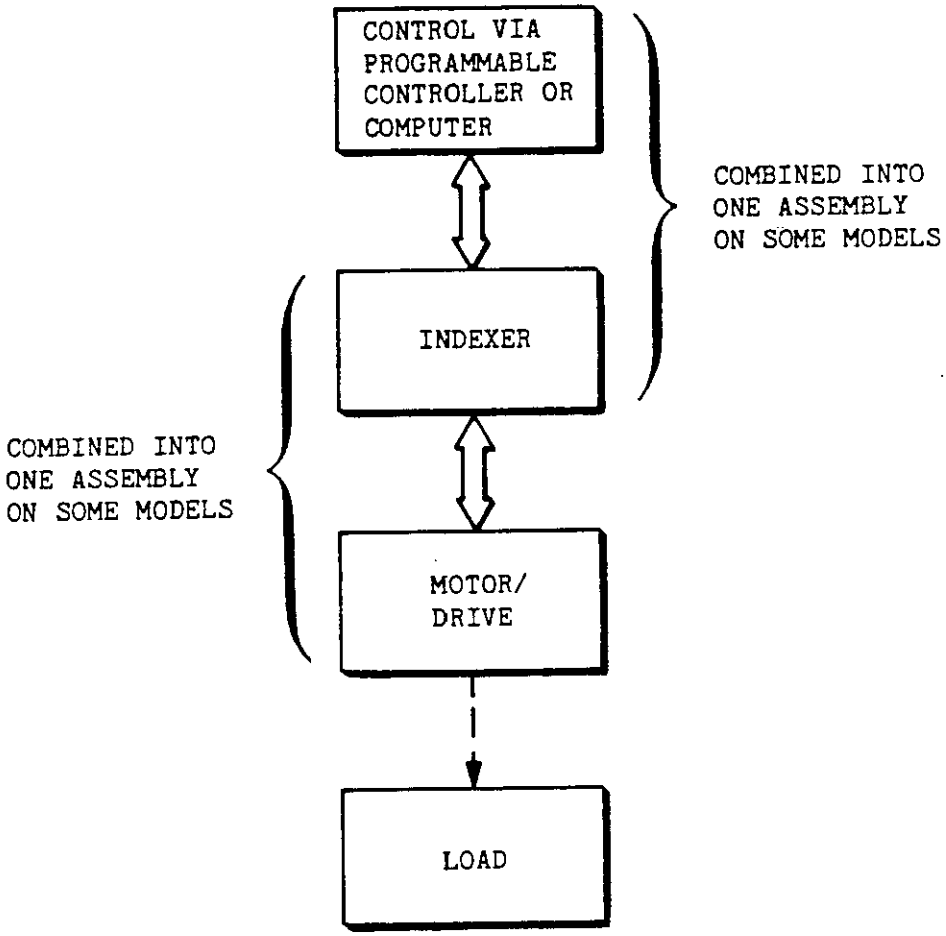


Figure 2-9. Indexer Controlled by Programmable Controlled Computer

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Chapter 3

INSTALLATION

3.1 OVERVIEW

This chapter describes the installation procedure for the Model 430 Indexer and its options and includes a simple performance check. More detailed performance and functional tests are described in Chapter 4.

3.2 INSPECTION — ALL UNITS

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

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

3.3 MECHANICAL ASSEMBLY AND INSTALLATION

3.3.1 ASSEMBLY

The Indexer is delivered as a complete, self-contained unit. No further assembly of the unit is required.

3.3.2 INSTALLATION

The unit can be secured to any convenient mounting surface using #10 bolts or larger. The operating environment must meet the requirements of Table 1-2.

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CAUTION

Do not connect the AC power line at this time. Complete connection to the motor/drive per section 3.4 before applying power to the Indexer.

3.4 ELECTRICAL CONNECTIONS

3.4.1. INDEXER TO MOTOR/DRIVE CABLE

Refer to Figure 3-1. Terminals 61 to 66 on the face of the Indexer are used to connect the Indexer to the Driver.

Note

Terminals 59 and 60 are used to drive non-Compumotor stepper-translators. Refer to section 3.6 for signal descriptions for Terminals 59 and 60.

Use the cable supplied with the motor/drive and proceed as follows:

a. Install the cable leads on the Indexer terminals per Figure 3-1.

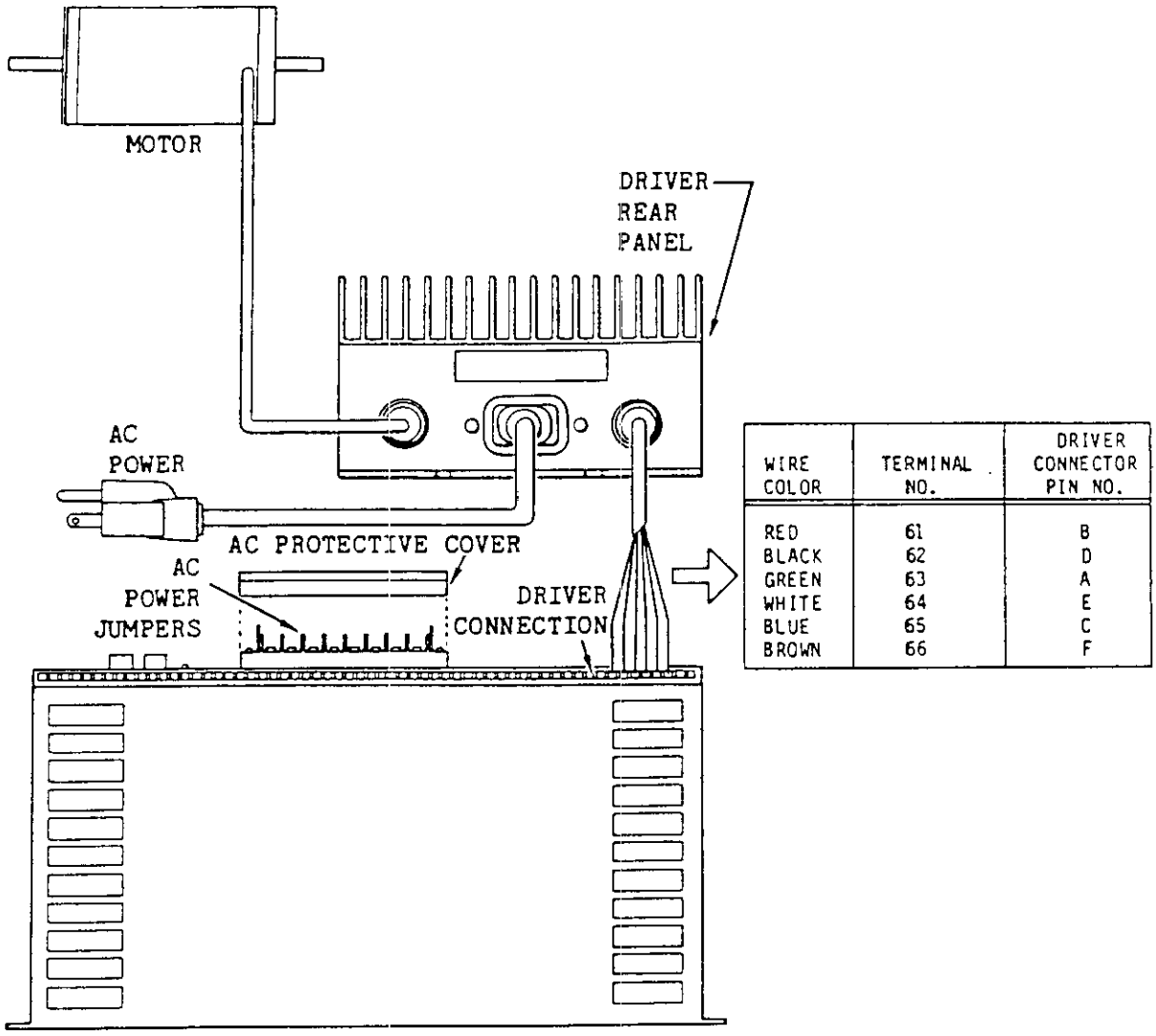
b. Connect the cable shield to chassis ground.

c. Connect the other end of the Indexer-to-motor/drive cable to the connector on the right hand side of the Driver rear panel (see Figure 3-1). Secure the connector by twisting the metal locking collar.

3.4.2 DRIVER TO MOTOR CONNECTION

Connect the cable connector to the left-hand connector on the rear panel of the Driver (see Figure 3-1). Secure the connector by twisting the plastic collar.

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WIRE COLOR	TERMINAL NO.	DRIVER CONNECTOR PIN NO.
RED	61	B
BLACK	62	D
GREEN	63	A
WHITE	64	E
BLUE	65	C
BROWN	66	F

NOTE: DRAWING NOT TO SCALE

Figure 3-1. Connection of Indexer to Motor/Drive

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3.4.3 AC POWER SELECTION JUMPERS

The 430 can be set for operation with different line voltages by changing the location of the AC power jumpers on the face of the Indexer.

****

WARNING

****

PLACE THE PROTECTIVE COVER SUPPLIED WITH THE INDEXER OVER THE AC POWER TERMINAL STRIP BEFORE APPLYING AC POWER TO THE INDEXER.

The AC power jumper positions for the different line voltages are shown in Figure 3-2. These jumpers are set at the factory for 120 VAC. Check the voltage level for the AC outlet that will be used to power the 430. Set the jumpers for the line voltage nearest the measured AC outlet voltage. The measured AC outlet voltage should be within ±10% of the jumper setting.

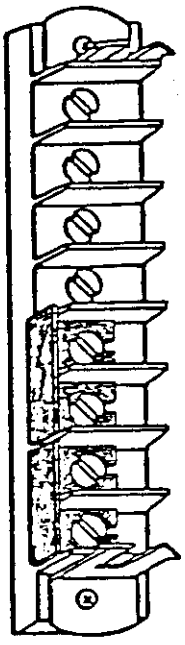
3.4.4. AC POWER CONNECTION

a. Remove protective cover (Figure 3-1) over the AC jumper block.
b. Connect a line cord to the AC jumper block as in Figure 3-1.
c. Place the protective cover (Figure 3-1) over the AC jumper block.
d. Connect the Indexer AC power leads to an AC power source corresponding to the values set with the jumpers in section 3.4.3.
e. Apply AC power to the Indexer. The green portion of the two-color **STATUS** indicator on the face of the 430 should light. If the **STATUS** indicator does not light REMOVE POWER and:

    1. Check the fuse (0.8 Amps) on the face of the 430.

    2. Check AC power distribution cable to the 430 and verify that voltage at the distribution point is correct. If the **STATUS** indicator still does not light, refer to section 1.5.

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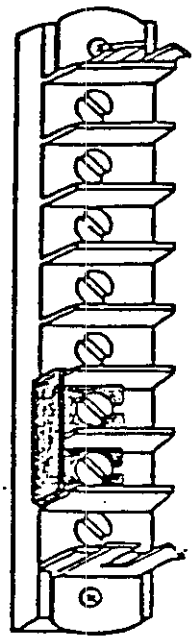


AC LINE -120 VAC (BLACK)

AC NEUT (WHITE)

AC GND (GREEN)

120 VAC



AC LINE -240 VAC (BLACK)

AC NEUT (WHITE)

AC GND (GREEN)

240 VAC

The 430's normal line input voltage was previously specified at 100, 120, or 240 VAC, any of which could be selected by inserting the correct jumpers on the front of the 430.

Now, the 430 may be configured only for 120 or 240 VAC operation. Adding the jumper for 100 or 220 VAC operation does nothing.

> NOTE: THIS APPLIES TO UNITS WITH SERIAL NUMBERS 553 AND HIGHER. DO NOT USE THE 100/220 JUMPER ON UNITS WITH SERIAL NUMBERS LESS THAN 553. TO DO SO WILL RESULT IN TRANSFORMER FAILURE.

The minimum and maximum voltages the 430 will nominally operate at are:

Input Voltage Selected	Minimum Operating Voltage	Maximum Operating Voltage
120 VAC	105 VAC	130 VAC
240 VAC	210 VAC	260 VAC

Figure 3-2. AC Power Jumper Settings

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The two-color **STATUS** indicator also serves as a fault detector. If there is an internal fault, the indicator changes from green to red. If the Indicator is red,

a. Make momentary connection between Terminals 22 and 24 to RESET the Indexer

b. If the condition persists, refer to Section 1.5.

3.5 POST-SHIPMENT TEST

This test is based on the use of a "Default Move." The operating parameters for a "Default Move" are set with a set of 80 DIP switches and jumpers internal to the 430 (see Figure 3-3). These DIP switches and jumpers are set at the factory, as shown in Table 3-1. If these DIP switches are changed before the tests of section 3.5 are run, the velocity, acceleration, and distance values achieved may be different from those described in Sections 3.5.1 through 3.5.4.

3.5.1 POST-SHIPMENT TEST SETUP

a. Verify that the DIP switches are set to the factory installed values.

Note

Early versions of the 430 (before S/N300) use jumper blocks rather than dip switches.

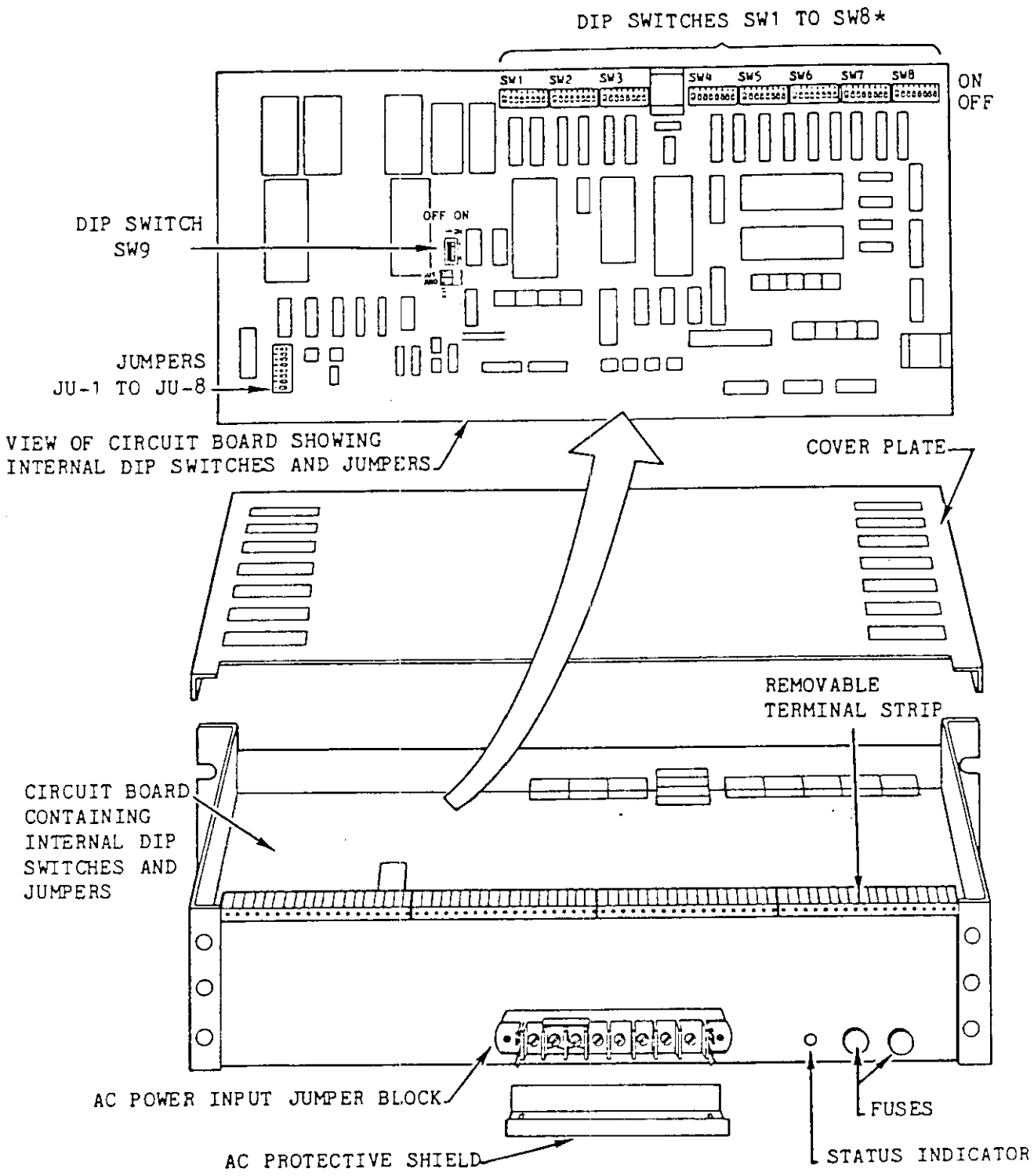
b. Verify that the temporary jumpers between Terminals 42, 43 (**CW** and **CCW LIMITS**) and 22 (**GROUND**) installed at the factory are in place.

Note

Connection of normally closed End-of-Travel limit switches is recommended in place of these jumpers on final installation.

c. Connect two test leads to Terminal 22 suitable for making momentary contact with the other terminals.

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*If your 430 has jumpers and not switches, refer to Appendix C.

Figure 3-3. Model 430 Indexer Internal DIP Switches

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Table 3-1. Model 430 Factory DIP Switch and Jumper Settings

DIP Switch	Setting	DIP Switch	Setting	DIP Switch	Setting
SW1-1	ON	SW5-1	OFF	SW9-1	OFF
SW1-2	OFF	SW5-2	OFF	SW9-2	OFF
SW1-3	OFF	SW5-3	OFF	SW9-3	OFF
SW1-4	OFF	SW5-4	OFF	SW9-4	OFF
SW1-5	OFF	SW5-5	OFF		
SW1-6	OFF	SW5-6	OFF		
SW1-7	OFF	SW5-7	OFF		
SW1-8	OFF	SW5-8	OFF		
SW2-1	OFF	SW6-1	OFF	JU-1	OFF
SW2-2	OFF	SW6-2	OFF	JU-2	OFF
SW2-3	OFF	SW6-3	OFF	JU-3	OFF
SW2-4	OFF	SW6-4	OFF	JU-4	OFF
SW2-5	OFF	SW6-5	OFF	JU-5	OFF
SW2-6	OFF	SW6-6	OFF	JU-6	OFF
SW2-7	OFF	SW6-7	OFF	JU-7	OFF
SW2-8	ON	SW6-8	OFF	JU-8	OFF
SW3-1	OFF	SW7-1	ON	JU-9	OFF
SW3-2	OFF	SW7-2	OFF	JU-10	OFF
SW3-3	OFF	SW7-3	ON		
SW3-4	OFF	SW7-4	OFF		
SW3-5	ON	SW7-5	OFF		
SW3-6	OFF	SW7-6	ON		
SW3-7	ON	SW7-7	OFF		
SW3-8	OFF	SW7-8	OFF		
SW4-1	ON	SW8-1	OFF		
SW4-2	OFF	SW8-2	OFF		
SW4-3	ON	SW8-3	OFF		
SW4-4	OFF	SW8-4	OFF		
SW4-5	OFF	SW8-5	OFF		
SW4-6	ON	SW8-6	OFF		
SW4-7	OFF	SW8-7	OFF		
SW4-8	OFF	SW8-8	OFF		

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3.5.2 TEST 1 -- CLOCKWISE CONTINUOUS ROTATION

a. Momentarily ground Terminal 35 (**START**) (note: The Data imputs must be set to zero). The motor will accelerate and then run continuously at a rate of 200,000 steps per second. (Divide by the motor resolution to determine the number of revolutions per second).

b. Momentarily ground Terminal 33 (**STOP**) to stop the motor.

3.5.3 TEST 2 -- COUNTERCLOCKWISE CONTINUOUS ROTATION

a. Make a temporary connection between Terminal 36 (**DIRECTION**) and ground.

b. Repeat Test 1 (Section 3.5.2). The motor should rotate in the opposite direction (**CCW**) and run continuously at the same speed reached in Test 1.

3.5.4 TEST 3 -- PRESET MOVE

a. Move the temporary connection from Terminal 36 to Terminal 37 (**PRESET**).

b. Momentarily ground the **START** terminal. The motor should accelerate, move 25,000 steps, and then stop. If the tests above were successful, the unit is ready for operational setup and programming. Additional functional and performance tests are presented in Chapter 4.

3.6 INPUT AND OUTPUT CONNECTIONS

3.6.1 GENERAL

Terminal 22 (**GROUND**) is the ground for all input and output signals. The 430 has two types of inputs and two types of outputs as follows:

a. Optically isolated inputs for connection to external devices such as switches, programmable controllers, and computers.

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b. Inputs reserved for connection to incremental Encoders that are installed for use of the 430 Position Tracking capability.

c. Open-collector transistor outputs. These outputs can be pulled up to an external voltage (30 VDC max).

d. Outputs reserved for driving Compumotor motor/drives or non-Compumotor stepper-translators.

Table 3-2 summarizes the 430 inputs. The inputs are grouped by signal characteristics.

3.6.2 OPTICALLY ISOLATED INPUTS

A schematic of the optically isolated 430 inputs is presented in Figure 3-4. These inputs are current "sourcing" inputs and require "sinking" outputs or contact-closure type outputs to drive them. "TTL" output modules in a "LOW" state and open-collector circuits exhibit the proper current sinking characteristics.

The 430 inputs can be driven by switching them to ground or sinking a 15 mA current to ground. These inputs are pulled up to an internal +5 VDC source. The same source is available on Terminal 45 (**+5 VOLTS**) for external use.

Internal blocking diodes allow input voltages of up to 30 VDC to be applied to the optically isolated inputs.

The polarity of the 430 input signals is set at the factory for high = false, low = true. The internal DIP switches (section 3.7) can be used to change input signal polarity so that low = false and high = true.

The optically isolated 430 inputs can be subdivided into two functional groups, Indexer Operation Inputs (Section 3.6.2.1) and Programming Inputs (Section 3.6.2.2).

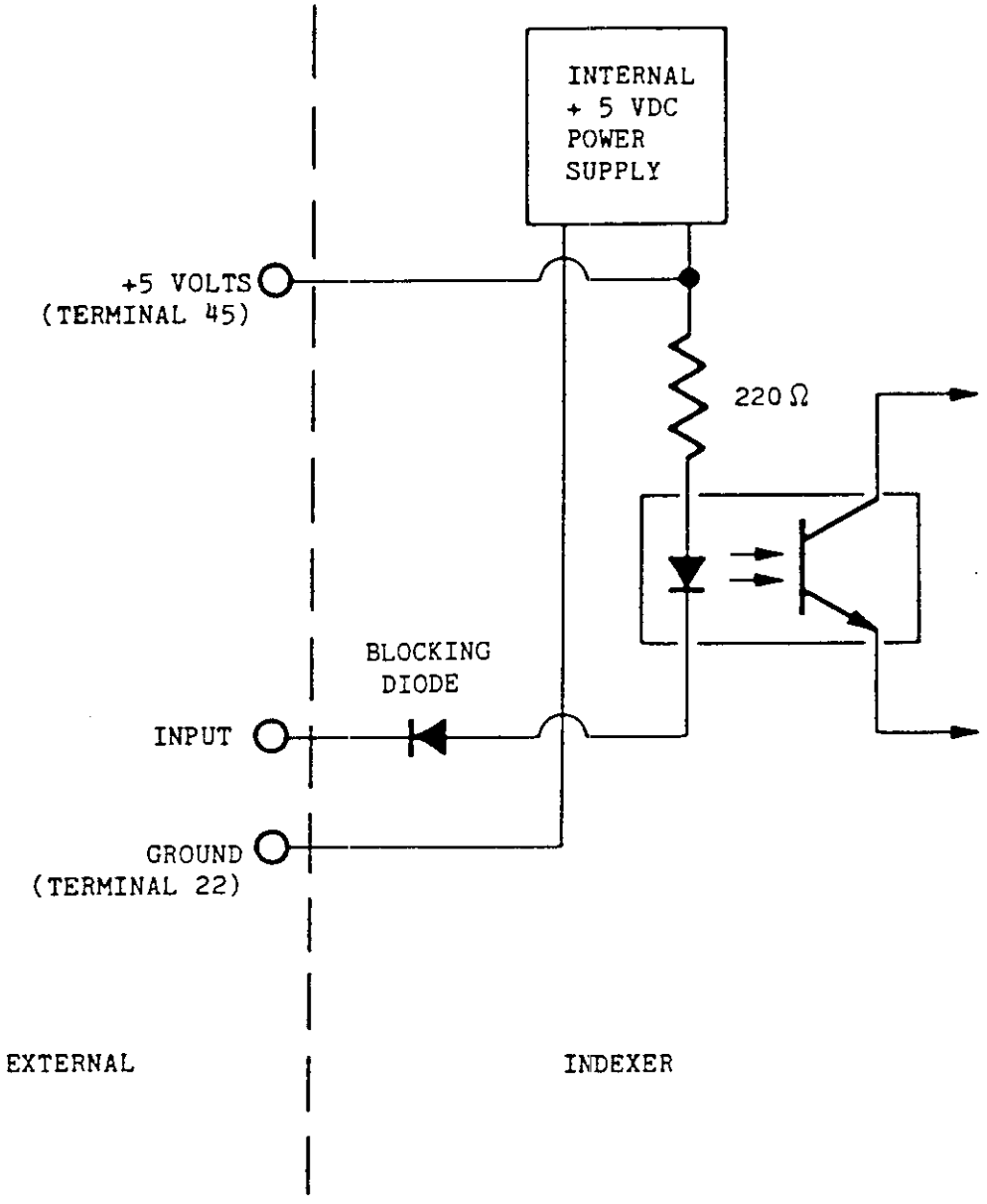
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Table 3-2. Model 430 Indexer Input Connections

Pin Number	Signal Name	Max Low Voltage	Min High Voltage	Timing
1	BIT 0	0.6	3.0	Must remain stable while strobes are active (lines 17-21)
2	BIT 1	0.6	3.0	
3	BIT 2	0.6	3.0	
4	BIT 3	0.6	3.0	
▼	▼			
16	BIT 15	0.6	3.0	
17	COMMAND STROBE	0.6	3.0	Low for 200 microseconds followed by high for at least 2 milliseconds
18	DATA STROBE 1	0.6	3.0	
19	DATA STROBE 2	0.6	3.0	
20	DATA STROBE 3	0.6	3.0	
21	DATA STROBE 4	0.6	3.0	
24 *	RESET	0.6	3.0	
27 *	SPECIAL	0.6	3.0	
39 *	TRIGGER 1	0.6	3.0	
22	GROUND	--	--	
25 *	JOG +	0.6	3.0	Low for at least 2 milliseconds
26 *	JOG -	0.6	3.0	
29 *	OUT DISABLE	0.6	3.0	
32 *	SHUTDOWN	0.6	3.0	
33 *	STOP	0.6	3.0	
34 *	GO HOME	0.6	3.0	
35 *	START	0.6	3.0	
44 *	HOME LIMIT	0.6	3.0	
36 *	DIRECTION	0.6	3.0	A change in level must be present for at least 2 milliseconds
37 *	PRESET	0.6	3.0	
38 *	ABSOLUTE	0.6	3.0	
40 *	TRIGGER 2	0.6	3.0	
41 *	TRIGGER 3	0.6	3.0	
42 *	CW LIMIT	0.6	3.0	80 microseconds
43 *	CCW LIMIT	0.6	3.0	
47 #	CHANNEL A+	0.8	4.0	40 KHz is the max response rate
48 #	CHANNEL A-	0.8	4.0	
49 #	CHANNEL B+	0.8	4.0	
50 #	CHANNEL B-	0.8	4.0	
51 #	CHANNEL Z+	0.8	4.0	
52 #	CHANNEL Z-	0.8	4.0	

* Discrete command inputs
# Encoder inputs

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MAXIMUM VOLTAGE FOR "LOW" = 0.6 VDC

MINIMUM VOLTAGE FOR "HIGH" = 3.0 VDC

Figure 3-4. Optically Isolated Inputs

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3.6.2.1 **Indexer Operation Inputs.** The following 430 inputs are defined as Indexer Operation Inputs:

Terminal 24 - RESET: A low signal on this input causes the Indexer to execute the power-on sequence. If this input is held low, the Indexer will remain in an inactive state.

Terminal 25 - JOG +, Terminal 26 - JOG -: A low signal on this input causes the Indexer to move at the presently defined JOG velocity and acceleration. The "+" and "-" refer to clockwise and counterclockwise motor rotation respectively. A high input stops the move. A response lag of up to 2 milliseconds is possible.

Terminal 27 - SPECIAL: May be assigned to any command in the command list using the **DEFINE THE SPECIAL INPUT** command (Command **[0301]**). The default command executed when this input is activated is the **PERFORM A SEQUENCE** command (Command **[0065]**). The number of the sequence to be performed is read by the Indexer from the 16 data inputs, **BIT 0** through **BIT 15**, when the input goes active. A response lag of up to 2 milliseconds is possible.

Terminal 29 - OUT DISABLE: Causes the four 430 output status bits (**ERROR, READY, OUT1,** and **OUT2**) to deactivate. Allows several 430 Indexers to be time multiplexed to the same controller inputs. The controller can use this input to select one of the multiplexed 430s. Worst case enable/disable delay times are 100 microseconds.

Terminal 32 - SHUTDOWN: A low signal on this input commands the Driver to shut off current to the Motor, eliminating torque while the low signal persists. This input can be disabled using BCD Commands **[0018]** and **[0019]**. Worst case lag is 2 milliseconds.

Terminal 33 - STOP: A low signal on this input issues a STOP command to the Indexer, causing the motor to decelerate to a stop. If a PREDEFINED SEQUENCE is being performed, it will be discontinued. The signal must be low for 2 milliseconds to ensure operation.

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Terminal 34 - GO HOME: A low signal on this input will issue an open-loop **GO HOME** command using the presently defined parameters. The **DIRECTION** input (Terminal 36) will determine the direction of initial search. For further details, refer to section 6.5.3. If the Indexer is operating in the closed-loop mode (position maintenance enabled) this input will generate a Go to Closed-Loop Home operation as described by the command of the same name. The signal must be low for 2 milliseconds to ensure operation.

Terminal 35 - START: MULTIFUNCTION INPUT

a. Initiate Default Move - If the signals on Terminals 1 to 16 equal a BCD zero, a low signal on this input initiates a move using the currently defined acceleration and velocity values plus the parameters defined by Terminals 36 (**DIRECTION**), 37 (**PRESET**), and 38 (**ABSOLUTE**).

b. Initiate Predefined Move - If the signals on Terminals 1 to 16 represent a BCD number between 1 and 40, and a PREDEFINED MOVE with that number assigned is stored in working memory, a low signal on this input will initiate that PREDEFINED MOVE. In this mode the state of Terminals 36, 37, and 38 does not affect the move (refer to Chapter 5).

c. Initiate Serial Programming Mode - If **STOP** (Terminal 33) is grounded, a low signal on this input places the Indexer in Serial Programming Mode. See 3.6.2.3 for details.

Terminal 36 - DIRECTION: Sets direction of Default Move. (See Figure 3-5 for rotation direction definition.) A low signal on this input sets a counterclockwise direction of motor rotation. If an ABSOLUTE move is initiated, **DIRECTION** determines which side of zero position (see section 6.4.1) is used as the referenced point.

Terminal 37 - PRESET: Controls whether the Default move is continuous or a fixed number of steps. A high signal on this input results in continuous motor shaft rotation. A low signal on this input results in a move of a fixed number of steps. The move distance is set by the

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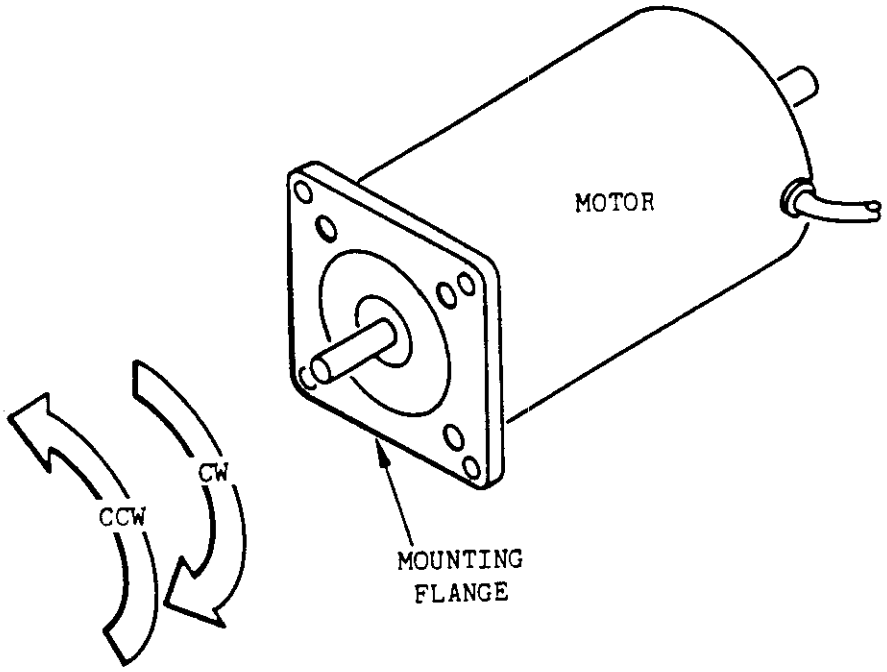


Figure 3-5. Direction of Rotation Determination

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internal DIP switches (Default Move). The reference point for the PRESET move is established by the status of the ABSOLUTE input (Terminal 38). If **ABSOLUTE** is high, the motor will move a fixed number of steps from the current position. If **ABSOLUTE** is low, the move will be referenced to absolute zero instead of current position.

Terminal 39, 40, 41 - TRIGGER 1,2,3: These inputs are used to signal the Indexer that an external event has occurred. (See section 6.7.1.5 for details.)

Terminals 42, 43 - CW LIMIT,CCW LIMIT: These inputs are used to protect the load from overtravel in a given direction. The direction of travel is referenced to rotation of the motor shaft (Figure 3-5). A low signal on these inputs enables rotation in the indicated direction.

> Note
>
> For normal operation of the Indexer these inputs must be held low by either normally closed limit switches or jumpers to ground. The Indexer is shipped with temporary jumpers installed on Terminals 42 and 43.

A high signal on one of these inputs will prevent rotation in the indicated direction and allow rotation in the opposite direction. There is an 80 microsecond worst case response time for these inputs.

The limit switches are connected between Terminal 22 (**GROUND**) and Terminal 42 (**CW LIMIT**) or Terminal 43 (**CCW LIMIT**).

If initial systems tests are to be performed with the motor connected to a limited-travel mechanism, it is recommended that limit switches be installed to protect the mechanism. The motor itself can be stalled indefinitely without damage. You can reference load travel to shaft rotation by grounding the **JOG +** input (Terminal 25). This will rotate the motor shaft clockwise. Typical switches include mechanical contact closures, optical switches, or Hall-effect devices. The easiest to mount and wire are typically the mechanical-type switches. A normally closed contact is required for operation of the Indexer.

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Install the limit switches so that there is room for some travel before the load travel stops.

Terminal 44 - HOME LIMIT: This input is used to signal the Indexer that the load is located at the position designated as the **HOME** position. A low signal on this input will cause the motor to stop during a GO HOME operation. For the closed-loop **GO HOME** command, this input may be used in conjunction with the Encoder Z channel index signal, if necessary, to select one of multiple index signals of the Encoder. Refer to section 6.8.6 for additional details.

3.6.2.2 **Parallel Interface Programming Inputs.** These inputs form a parallel BCD interface that can be used to program the 430. The Programming Inputs include:

Terminal Number	Name	Value
1	BIT 0	1
2	BIT 1	2
3	BIT 2	4
4	BIT 3	8
5	BIT 4	10
6	BIT 5	20
7	BIT 6	40
8	BIT 7	80
9	BIT 8	100
10	BIT 9	200
11	BIT 10	400
12	BIT 11	800
13	BIT 12	1000
14	BIT 13	2000
15	BIT 14	4000
16	BIT 15	8000

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Terminal Number	Name
17	COMMAND STROBE
18	DATA STROBE 1
19	DATA STROBE 2
20	DATA STROBE 3
21	DATA STROBE 4

The 430 Programming Inputs consist of:

a. 16 data inputs (**BIT 0** to **BIT 15**)
b. 4 data strobe inputs (Data 1 to Data 4)
c. 1 command strobe input

The 16 data inputs constitute a data word. The strobe inputs, which are always active low, are used to enter a "word" into 430 memory.

The optional Model 431 Input Panel can be used to manually program the 430 via the 16 data inputs and the 5 strobe lines (see Figure 3-6). Refer to

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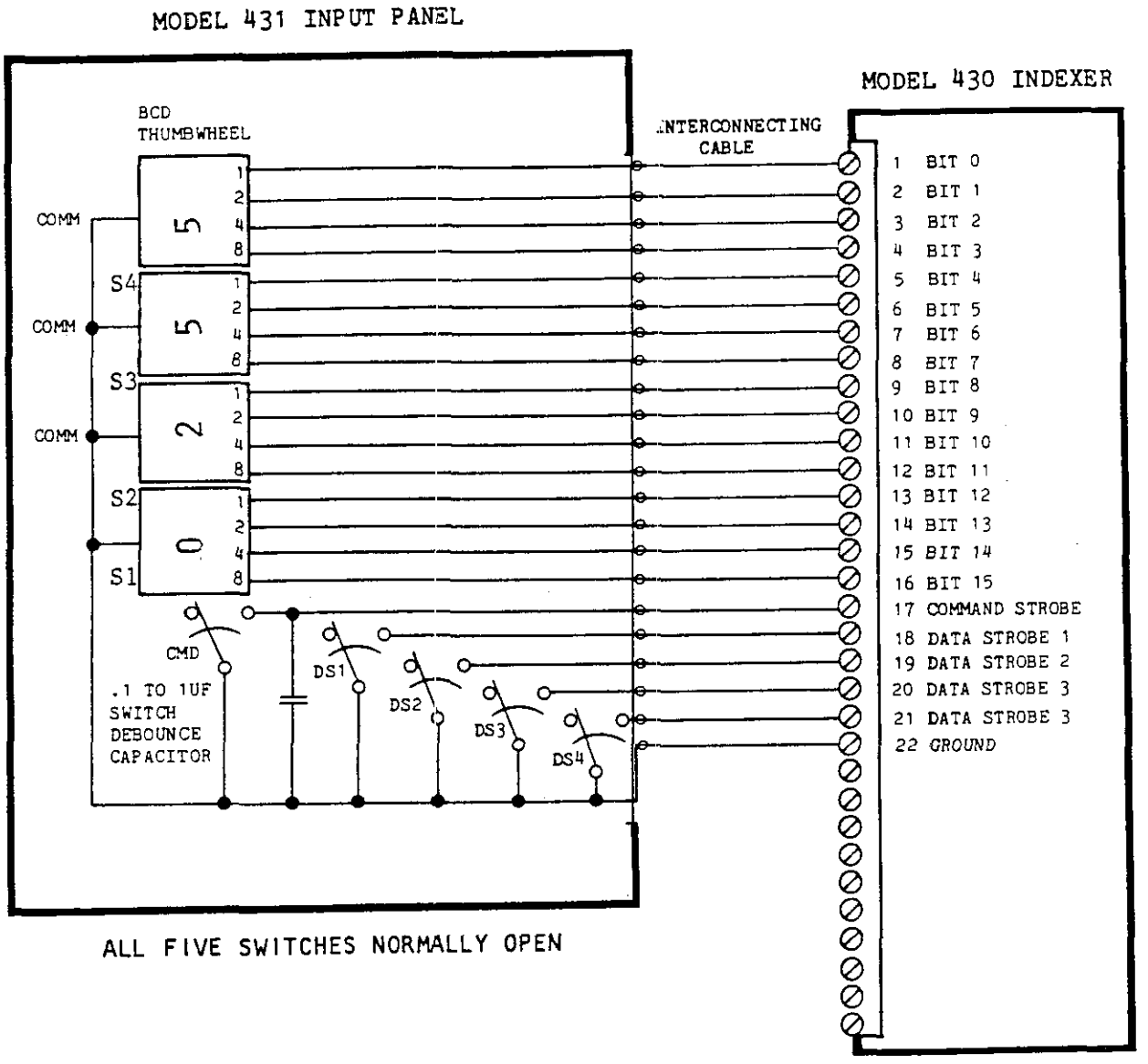


Figure 3-6. Model 431/Model 430 Interconnection

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Chapter 6 for a description of 430 programming and to Appendix A for examples of Model 431 use.

A programmable controller can be used to program the Indexer (Figure 3-7). Block transfers of an entire word are used. The data word would be written on one programming cycle scan, the proper strobes would be turned ON during the next scan, and the strobes would be turned OFF on the following scan. This sequence provides the most reliable way of programming the Indexer via the parallel interface.

3.6.2.3 **Serial Interface Programming Inputs.** A terminal or computer can be used to program the 430 via the RS-232C compatible serial input interface.

There are several departures from the normal definition of RS-232C, as follows:

a. The interface protocol corresponds to standard RS-232C insofar as signal timing for a single command line is concerned. (See section 5.4.4 for a discussion of command entry via the serial interface). However, the Indexer is not able to receive the commands at the maximum rate.

b. Internal processing of command lines requires a minimum delay of 10 milliseconds between commands. This is no problem when using a terminal, but computers and programmable controllers can transmit faster than the 430 can receive. It may prove necessary to insert a delay between commands. Furthermore, the memory operation commands **SAVE**, **RECALL**, and **AUTORECALL** require longer delays, which can be as much as 20 seconds for large programs.

c. The electrical characteristics of the serial input and output do not conform to the IEEE standard for RS-232C. The 430 input requires only a 0- to 5-Volt signal, as opposed to the standard ± 12 Volts. The 430 input will not be damaged by a standard RS-232C signal. The Indexer output signal swings between zero and whatever voltage is applied to the **PULLUPS** input. Not all RS-232C equipment will read this signal due to the absence of a negative voltage, but most will. This includes the IBM PC, Tandy Model 100, ADM 3, and others.

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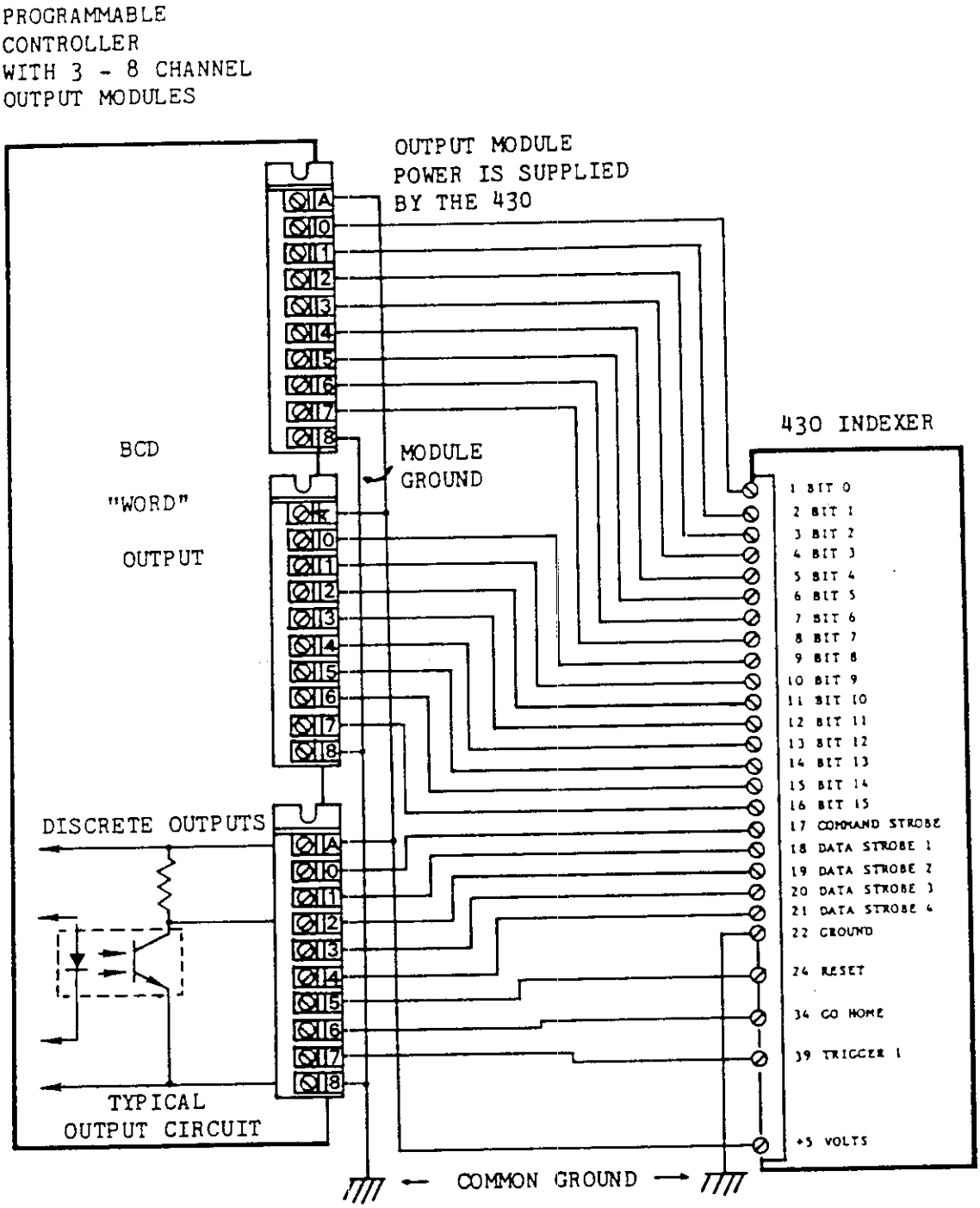


Figure 3-7. Typical Programmable Controller Connection

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When the Serial Input mode is used, the Indexer is unavailable for any other operation. No serial commands will be accepted by the 430 unless it has been put in Serial Programming Mode. Conversely, once it has been set in the Serial Input Mode, it will not execute any commands until it has been taken out of the Serial Programming Mode.

Serial Communication Protocol -- The Indexer will receive and retransmit (echo) ASCII characters at 1200 baud with 8 data bits, 2 stop bits and no parity.

The interface uses the RS-232C Transmit, Receive, and Ground signals only, and does not support any handshaking signals (such as Clear to Send), nor does it support the "XON/XOFF" convention.

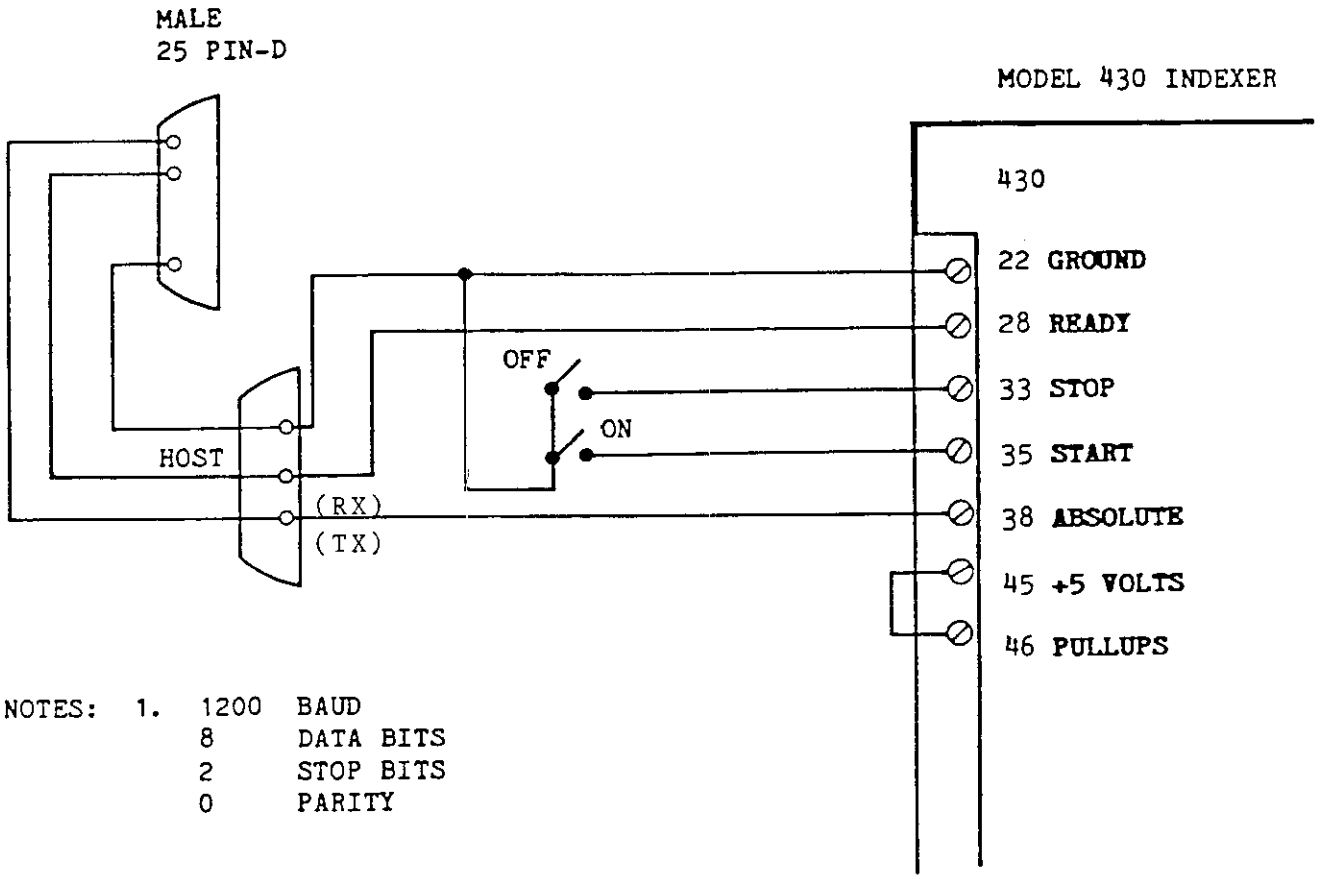
Note

The echo connection is not strictly required, but if the transmitting device is configured in the full duplex mode, transmitted characters will not be displayed until they are echoed from the Indexer. This serves as a useful indication that the interface is working.

Serial Interface Connections -- To wire the Indexer for serial communications, three wires must be connected from the host computer or terminal to the 430 (see Figure 3-8). The terminal or computer will probably be configured as "Data Terminal Equipment" (DTE). If so, the "Transmitted Data" signal is connected to the 430 **ABSOLUTE** input. The "Received Data" line is connected to the **READY** output to allow characters to be echoed by the Indexer. The communications signal ground connects to the 430 **GROUND**. If the RS-232C device has the standard 25-pin "D" connector, the DTE connection is made as follows:

RS-232C "D" Connector Pin		430 Terminal
2	(transmit)	38 **ABSOLUTE**
3	(receive)	28 **READY**
7	(common)	22 **GROUND**

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NOTES: 1. 1200 BAUD
8 DATA BITS
2 STOP BITS
0 PARITY

2. **ABSOLUTE** AND **READY** MAY NEED TO BE SWITCHED

Figure 3-8. Wiring for Serial Communications

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Note

The transmit and receive connections above must be reversed if the input device is designated as "Data Communications Equipment" (DCE).

Finally, Terminal 45 (**+5 VOLTS**) must be connected to Terminal 46 (**PULLUPS**) to provide voltage for the echo signal.

If the Indexer does not respond when it is configured for serial operation, try swapping pins 2 and 3 of the cable connector that mates with the RS-232C output of the terminal or computer. Refer to Chapter 5 for serial programming procedures.

Actuating the Serial Input Mode -- A necessary condition for activating the Serial Input mode is that none of the Discrete Command inputs or Strobe inputs be active. The Serial Input Mode is entered by connecting the **START** and **STOP** inputs to **GROUND** (see section 3.6.2.1). At this point, the Indexer will echo characters that are sent to it.

Exiting the Serial Input Mode -- To exit this mode, lift the **GROUND** connections from the **START** and **STOP** terminals; then either ground the **ABSOLUTE** input or send an additional character to return to the operating mode.

3.6.3 ENCODER INPUTS

Encoders are used for Position Tracking (see section 3.8). The 430 Encoder inputs (Terminals 47 through 52) are configured to use single-ended inputs driven by a 5- to 30-Volt digital (square wave) Encoder output (see Figure 3-9 and section 3.7). The Encoder can be powered by the **+5 VOLT** (Terminal 45) output of the 430.

3.6.4 OPTICALLY ISOLATED OUTPUTS

Table 3-3 summarizes the 430 outputs. The outputs are grouped by signal characteristics.

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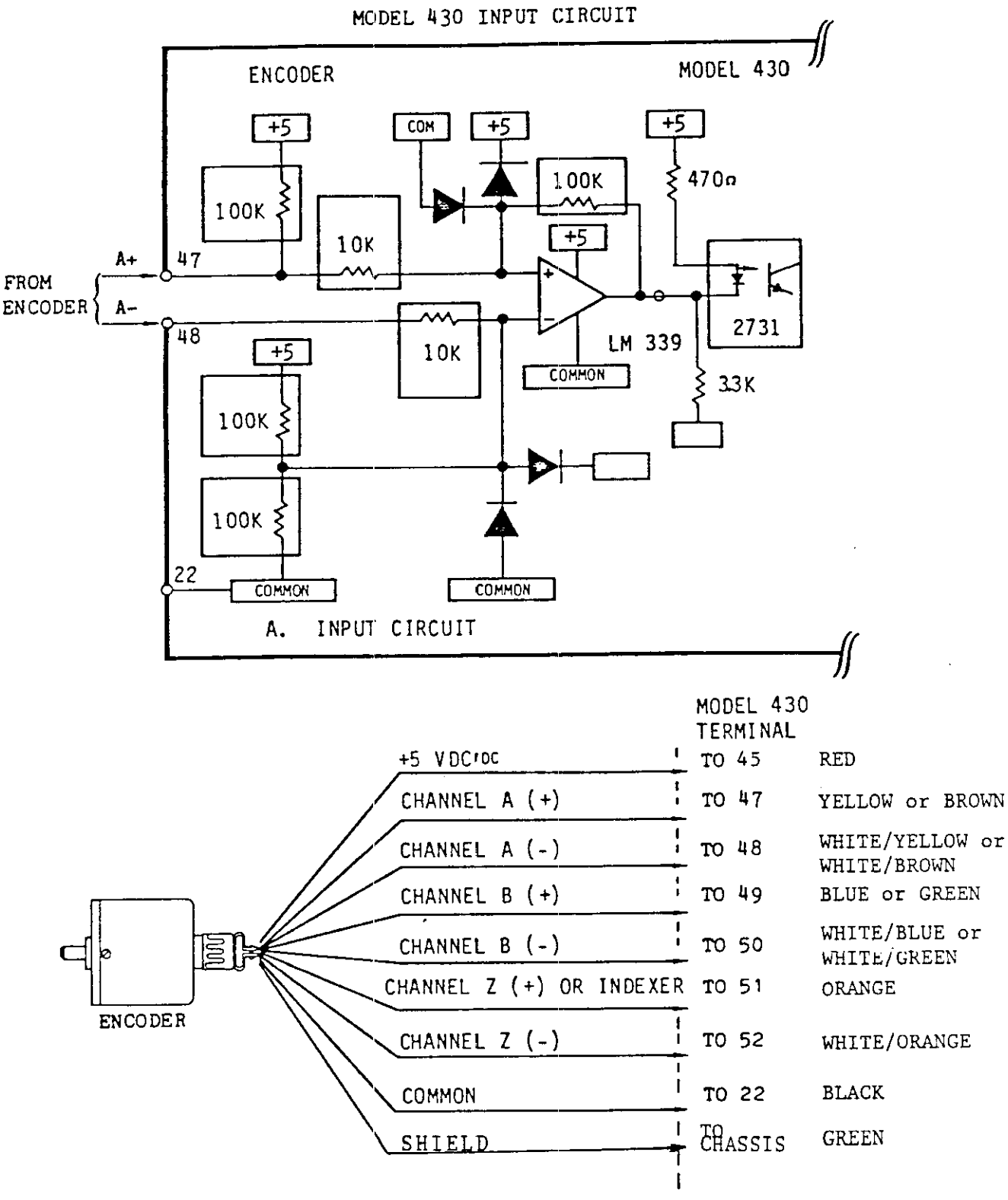


Figure 3-9. Typical Model 430/Encoder Interface

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Table 3-3. Model 430 Indexer Output Connections

Pin No.	Signal Name	Description	Rating
22	GROUND	Common reference for all front panel signals and the +5 volt (pin 45) power supply.	
23 28 30 31	ERROR READY OUT 1 OUT 2	Open collector (connected to 4.7K pullups via pin 46).	40 V max 100 mA sink
45	+5 volts	Used to power external devices	1.0 amp +5.0 volt regulated DC
46 59 60	Pullups CW STEP CCW STEP	Open collector with no pullup. These are used to drive non-Compumotor stepper translators	40 V max, 100 mA sink. Pulse width is greater than 10 microseconds when operated on velocity range 1
61 62	STEP + STEP -	Differential output to Driver	0.75 V Max low, 4.5 V min high, sink ± 60 mA. Min pulse width is 1.0 microsecond
63 64	DIRECTION + DIRECTION -	Differential output to Driver	0.75 V max low, 4.5 V min high, sink ± 60 mA
65 66	SHUTDOWN + SHUTDOWN -	+ differential - output to Driver	0.75 V max low 4.5 V min high, sink ± 60 mA

53-58 are reserved terminals.

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TABLE 3-3A

MODEL 430 MOTOR/DRIVER CONNECTOR COLOR CODES

WIRING TABLE			
WIRE COLOR	TERMINAL NUMBER	DRIVER CONN. PIN NUMBER	FUNCTION
RED	61	1	STEP
GREEN	63	2	DIRECTION
DRAIN	———	5	SHIELD *
ORANGE	55	6	GEARSHIFT
BROWN	53	7	FAULT RESET
BLUE/WHITE	57	11	BOOST
BLACK	62	14	STEP RETURN
WHITE	64	15	DIR RETURN
BLUE	65	16	SHUTDOWN
YELLOW	66	17	SHUTDOWN RTN
VIOLET	56	18	GEARSHIFT RTN
GREY	54	19	FLT RESET RTN
YELLOW/WHITE	58	23	BOOST RTN

*(Connect to 430 chassis)

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The optically isolated output circuits, shown schematically in Figure 3-10, are open-collector, optically coupled transistors capable of sinking 100 mA when switched ON. When OFF, these outputs behave like an open circuit unless pulled up through resistors to an external voltage source. The optically isolated outputs, which can be pulled up by connecting an external voltage (5 to 30 VDC) to Terminal 46 (**PULLUPS**) are:

Terminal 23 - ERROR: When ON, indicates an error exists that could prevent receipt of a command. If an error output occurs, the Indexer should be RESET. If valuable move definitions or sequences have not been saved previously, a **SAVE** command (see section 6.9.3) should be issued before the Indexer is **RESET** to save any prior programming. There is an 80-microsecond delay between the time the error occurs and the time the **ERROR** output becomes active.

Terminal 28 - READY: When active (low), indicates that the Indexer is ready to accept another command. **READY** status is updated every 2 milliseconds.

Terminal 30,31 - OUT1,OUT2: Optional outputs that may be turned on or off to signal external equipment (see section 6.10.2.1). Worst case time delay is 1 millisecond.

3.6.5 MOTOR/DRIVE OUTPUTS

Terminals 59 (**CW STEP**) and Terminal 60 (**CCW STEP**) are used to drive non-Compumotor stepper-translators. The signal characteristics are described in Table 3-3.

Terminals 61 to 66 are reserved for driving Compumotor motor/drives. The signal characteristics of these outputs are described in Table 3-3. Connection of Compumotor motor/drives to the Indexer was described in section 3.4.

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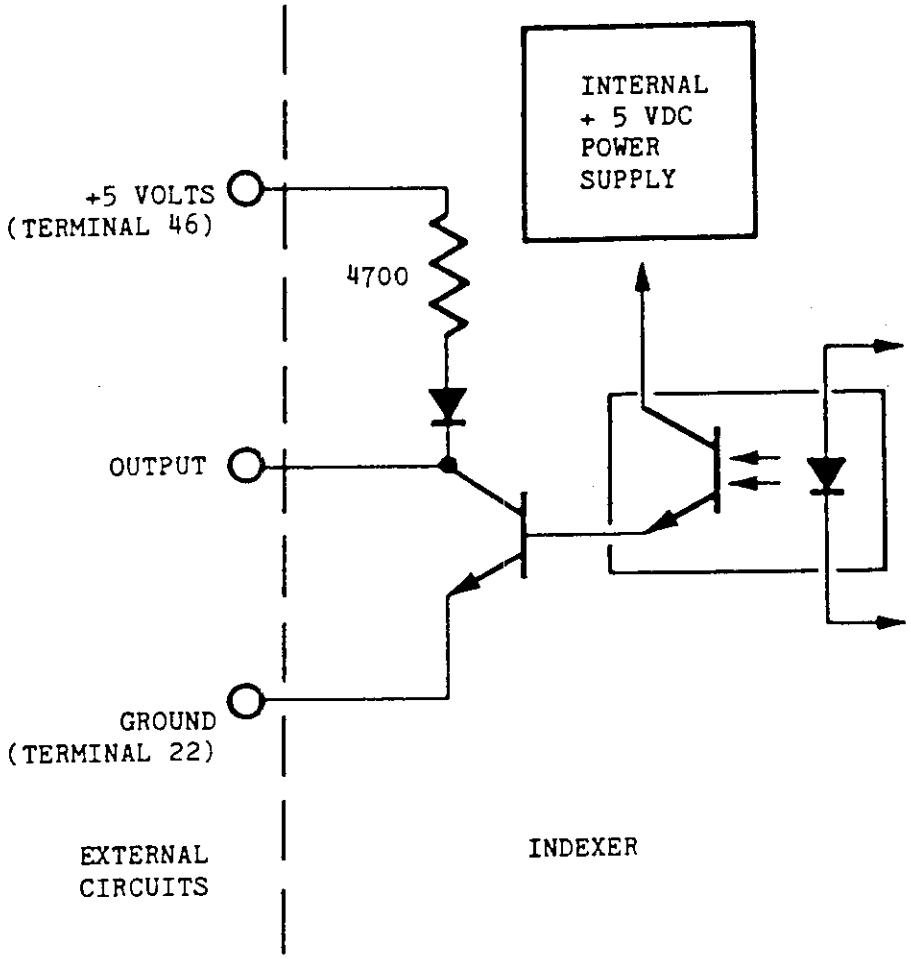


Figure 3-10. Optically Isolated Outputs

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3.6.6 UTILITY OUTPUTS

Terminal 22 (**GROUND**) provides a common ground for all Indexer inputs and outputs. This is not the same as chassis (earth) ground.

Terminal 45 (**+5 VOLTS**) provides a +5 VDC supply voltage that can be used to pull up the 430 optically isolated outputs and to power external Encoders for Position Tracking. This is a regulated supply that will provide up to 1 Amp for external use.

Terminal 46 (**PULLUPS**) is used to pull up the 430 optically isolated open collector transistor circuits described in Section 3.6.4. with an external voltage of +5 to +30 VDC.

3.7 SETTING THE INTERNAL DIP SWITCHES AND JUMPERS

Early versions of the 430 (before S/N 300) use jumper blocks rather than DIP switches.

3.7.1 GENERAL DESCRIPTION

The 430 is equipped with a set of 68 internal DIP switches and 10 jumpers that are used to set the power-up default values for a number of operating parameters (see Figure 3-3). Remove the left-hand side cover of the 430 (4 screws) to access the DIP switches and jumpers. DIP switches are used to establish the values for the default parameters. The default parameters, which include acceleration, acceleration range, velocity, velocity range, and distance, define a single move that can be controlled with the Indexer Operational inputs (e.g., **START, DIRECTION, PRESET, GO HOME**).

The DIP switches are also used to set the polarity of the data inputs and the Encoder inputs, and a number of other characteristics.

The location and identification number of each DIP switch and jumper were shown in Figure 3-3. The internal DIP switch descriptions are summarized in Table 3-4. The factory setting for each DIP switch is indicated by parentheses.

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The DIP switches are described in sections 3.7.3 through 3.7.18 in the same order as the listing presented in Table 3-4.

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Table 3-4. 430 Internal DIP Switches

DIP Switch Switch	DIP Switch Segments	Description	Factory Setting	Reference Section
SW1	-1 to -4	Go Home Approach Velocity Data (percent of Velocity X 10)	(1)	3.7.2
	-5 to -8	Least Significant Digit - Velocity Data	(0)	3.7.3
SW2	-1 to -4	2nd Digit - Velocity Data	(0)	
	-5 to -8	3rd Digit - Velocity Data	(8)	
SW3	-1 to -4	Most Significant Digit - Velocity Data	(0) (800)	
	-5	Velocity Range Multiplier - OFF=X25, ON=X250	(ON)	3.7.4
	-6 -7 -8	#3 Acceleration Range Multiplier - X 100 #2 Acceleration Range Multiplier - X 1,000 #1 Acceleration Range Multiplier - X 10,000 (All OFF: #4 Acceleration Range Multiplier - X10) (Select one)	(OFF) (ON) (OFF)	3.7.5
SW4	-1 to -4 -5 to -8	Least Significant Digit - Acceleration Data Most Significant Digit - Acceleration Data (Range #2 yields 25,000 steps/sec/sec)	(5) (2) (25)	3.7.6
SW5	-1	Home Approach Direction, ON=CCW, OFF=CW	(CW)	3.7.7
	-2	Home Limit Signal Edge, ON=CCW, OFF=CW	(CW)	3.7.8
	-3	Home Limit Polarity, ON=high true, OFF=low true **	(OFF)	3.7.9
	-4	BIT 0 to 16 Polarity, ON=high true, OFF-low true	(OFF)	3.7.10
	-5 to -8	Least Significant Digit - Position Data	(0)	3.7.11
SW6	-1 to -4 -5 to -8	2th Digit - Position Data 3th Digit - Position Data	(0) (0)	
SW7	-1 to -4 -5 to -8	4th Digit - Position Data 5th Digit - Position Data	(5) (2)	
SW8	-1 to -4 -5 to -8	6th Digit - Position Data Most Significant Digit - Position Data	(0) (0)	
SW9	-1	Encoder Direction Polarity (clockwise)	(OFF)	3.7.12
	-2	Z CHANNEL Polarity, ON=high true, OFF=low true	(OFF)	3.7.13
	-3	Home Limit Polarity, ON=high true, OFF=low true ***	(OFF)	3.7.14
Jumpers				
JU-1 to JU-5		Reserved: Do not Remove	(OFF)	3.7.15
JU-6		SHUTDOWN Out, ON=Differential, OFF=Single ended	(OFF)	3.7.16
JU-7		Direction Out, ON=Differential, OFF=Single ended	(OFF)	3.7.17
JU-8		Step Output, ON=Differential, OFF=Single ended	(OFF)	3.7.18
JU-9, 10		Reserved: Do not remove		

*(25000 steps = 1 revolution std motor)

**Open loop home input, closed loop home enable

***Closed loop home input (Z channel)

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Note

The Indexer reads these switches during the POWER-UP or RESET cycle. If the DIP switches are changed, the Indexer must be RESET before the changes are recognized by the Indexer. When a program is recalled from memory (see section 6.9.4), the program values will take precedence over the values set with the DIP switches.

Many of the DIP switches are used in groups of four to define a binary coded decimal (BCD) digit. The BCD digit must be set to a value between 0 and 9. Each DIP switch in a BCD group is assigned a pair of values as follows, 0 or 1, 0 or 2, 0 or 4, and 0 or 8. The DIP switch value is 0 when the DIP switch is set in the OFF position and the assigned value when the DIP switch is set in the ON position. The decimal value of the digit is the sum of the DIP switch values. For example, assume that DIP switches 1-1, 1-2, 1-3, and 1-4 define a BCD digit and are set as shown below:

DIP Switch	Assigned Value	Setting	Selected Value
SW1-1	1	ON	1
SW1-2	2	OFF	0
SW1-3	4	ON	4
SW1-4	8	OFF	0

Then, the BCD digit decimal value = Sum of Selected Values = 5

See Table 3-5 for DIP switches that represent BCD digits.

3.7.2 GO HOME APPROACH VELOCITY DATA (SW1-1 TO SW1-4)

Switches SW1-1 to SW1-4 = one BCD digit, minimum value = zero, maximum value = 9. (See section 3.7.3 for velocity definition.) GO HOME APPROACH VELOCITY DATA x 10 is the percent of move velocity to be used as the final approach velocity during a GO HOME operation (see section 6.4.7). GO HOME APPROACH VELOCITY = BCD digit value x 0.1 x velocity. See Section 3.7.8 for Open Loop Home Limit Signal Polarity.

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Table 3-5. DIP Switch Groups Used To Define BCD Digits

Indexer Function Defined	BCD Digits	DIP Switch Assignments			
		DIP Switch Values			
		1	2	4	8
GO HOME APPROACH VELOCITY DATA	d_1	SW1- 1	2	3	4
VELOCITY DATA LSD	d_1	SW1- 5	6	7	8
2nd Digit	d_2	SW2- 1	2	3	4
3rd Digit	d_3	SW2 5	6	7	8
MSD	d_4	Sw3- 1	2	3	4
ACCELERATION DATA LSD	d_1	SW4- 1	2	3	4
MSD	d_2	SW4- 5	6	7	8
POSITION DATA LSD	d_1	SW5- 5	6	7	8
2nd Digit	d_2	SW6- 1	2	3	4
3rd Digit	d_3	SW6- 5	6	7	8
4th Digit	d_4	SW7- 1	2	3	4
5th Digit	d_5	SW7- 5	6	7	8
6th Digit	d_6	SW8- 1	2	3	4
MSD	d_7	SW8- 5	6	7	8

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GO HOME DIRECTION definition. For example, to set GO HOME APPROACH VELOCITY to 30% of move velocity, set the DIP switches as follows:

DIP Switch	Assigned Value	Setting	Selected Value
SW1-1	1	ON	1
SW1-2	2	ON	2
SW1-3	4	OFF	0
SW1-4	8	OFF	0
		BCD digit value =	3

As an example, assume that you wanted to set the third digit of Position Data to 9. The DIP switches would be set as follows:

DIP Switch	Assigned Value	Setting	Selected Value
SW6-5	1	ON	1
SW6-6	2	OFF	0
SW6-7	4	OFF	0
SW6-8	8	ON	8
		Total	9

3.7.3 DEFAULT VELOCITY DATA (SW1-5 TO -8, SW2-1 TO -8, SW3-1 TO -4) (velocity x multiplier)

Equal to the sum of four BCD digits, d_4, d_3, d_2, d_1. The minimum value is 0 and the maximum value is 9999. Velocity in motor steps per second (steps/sec) = VELOCITY DATA x VELOCITY MULTIPLIER. (See section 3.7.4 for VELOCITY RANGE.) Example, $d_4d_3d_2d_1$ = 1,000, and VELOCITY RANGE = 25. Move velocity = 1,000 x 25 = 25,000 steps/sec. The DIP switches are assigned as follows:

d_4 (0 to 9 x 1000)	d_3 (0 to 9 X 100)	d_2 (0 to 9 x 10)	d_1 (0 to 9)
SW3-1 to -4	SW2-4 to -8	SW2-1 to -4	SW1-5 to - 8

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3.7.4 VELOCITY MULTIPLIER (SW3-5)

Selects one of two velocity data multipliers, x25 or x250. Velocity = VELOCITY DATA (Section 3.7.3) x VELOCITY MULTIPLIER. When SW3-5 set to OFF, VELOCITY DATA is multiplied by 25. When SW3-5 is ON, VELOCITY DATA is multiplied by 250.

3.7.5 ACCELERATION RANGE (SW3-6 TO -8)

Three DIP switches used to select one of four multipliers (x10, x100, x1,000, x10,000). Acceleration in steps/sec/sec = ACCELERATION DATA X ACCELERATION RANGE. Settings are as follows:

Acceleration Range	SW3 Settings		
	-8	-7	-6
x10	OFF	OFF	OFF
x100	OFF	OFF	ON
x1,000	OFF	ON	OFF
x10,000	ON	OFF	OFF

3.7.6 ACCELERATION DATA (SW4-1 to -8)

Equal to the sum of two digits, d_2, d_1. The minimum value is 1 and the maximum value is 99. BCD digit assignments are:

d_2 (0 to 9 X 10)	d_1 (0 to 9)
SW4-5 to -8	SW4-1 to -4

Acceleration in steps/sec/sec = ACCELERATION DATA x ACCELERATION RANGE (section 3.7.5). For example, if d_2d_1 = 25 and ACCELERATION RANGE = 1,000, acceleration = 25 x 1,000 steps/sec/sec = 25,000 steps/sec/sec.

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3.7.7 GO HOME FINAL APPROACH DIRECTION (SW5-1)

Single DIP switch used to select clockwise (SW5-1 ON) or counterclockwise (SW5-1 OFF) rotation. Used in conjunction with SW1-1 to 1-4. (See sections 3.7.2 and 6.5.2.)

3.7.8 OPEN LOOP HOME LIMIT SIGNAL EDGE (SW5-2)

Single DIP switch used to select clockwise edge (SW5-2 ON) or counterclockwise edge (SW5-2 OFF). Refer to section 6.5.2 for details.

3.7.9 OPEN LOOP HOME LIMIT SIGNAL POLARITY (SW5-3)

Single DIP switch used to select high true (SW5-3 ON) or low true (SW5-3 OFF). Refer to section 6.5.2 for details.

3.7.10 BIT 0 TO 16 POLARITY (SW5-4)

Single DIP switch to select high true (SW5-4 ON) or low true (SW5-4 OFF). This DIP switch sets the polarity of the 16 data inputs.

3.7.11 POSITION DATA (SW5-5 TO -8, SW6-1 TO -8, SW7-1 TO -8, SW8-1 TO -8)

Equal to the sum of seven digits (d_7, d_6, d_5 d_4, d_3, d_2, d_1). This defines the number of steps to the next position. The DIP switch assignments are:

$$\frac{d_7\ (0 \text{ to } 9 \times 1{,}000{,}000)}{\text{SW8-5 to -8}} + \frac{d_6\ (0 \text{ to } 9 \times 100{,}000)}{\text{SW8-1 to -4}} + \frac{d_5\ (0 \text{ to } 9 \times 10{,}000)}{\text{SW7-5 to -8}} +$$

$$\frac{d_4\ (0 \text{ to } 9 \times 1000)}{\text{SW7-1 to -4}} + \frac{d_3\ (0 \text{ to } 9 \times 100)}{\text{SW6-5 to -8}} + \frac{d_2\ (0 \text{ to } 9 \times 10)}{\text{SW6-1 to -4}} + \frac{d_1\ (0 \text{ to } 9)}{\text{SW5-5 to -8}}$$

For example, position data = 1,974,306 steps. For a 25,000 step/rev motor, this would equal 78.97^{+} revolutions.

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Note

The position data defines an incremental or absolute move depending upon the status of the **ABSOLUTE** Input (Terminal 38).

3.7.12 ENCODER DIRECTION INPUT POLARITY (SW9-1)

Single DIP switch used to select clockwise (SW9-1 OFF) or counterclockwise (SW9-1 ON) direction. (Refer to section 3.8.)

3.7.13 Z CHANNEL POLARITY (SW9-2)

Single DIP switch used to select high true (SW9-2 ON) or low true (SW9-2 OFF). (Refer to section 3.8.)

3.7.14 CLOSED LOOP HOME LIMIT SIGNAL POLARITY (Z CHANNEL) (SW9-3)

Single DIP switch used to select high true (SW9-3 ON) or low true (SW9-3 OFF). (Refer to section 6.3.2)

3.7.15 RESERVED JUMPERS (JU-1 to JU-5)

Should be set as follows:

JU-1 OFF, JU-2 OFF, JU-3 OFF, JU-4 OFF, JU-5 OFF

3.7.16 SHUTDOWN OUTPUT SIGNAL (JU-6)

Single DIP switch used to select Differential output (JU-6 ON) or single-ended output (JU-6 OFF). Use of the differential output is recommended for output signals to optimize noise immunity.

3.7.17 DIRECTION OUT (JU-7)

Single DIP switch used to select Differential output (JU-7 ON) or single-ended output (JU-7 OFF).

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3.7.18 STEP OUTPUT (JU-8)

Single DIP switch used to select Differential output (JU-8 ON) or single-ended output (JU-8 OFF).

3.8 POSITION TRACKING

3.8.1 POSITION TRACKING FUNCTIONS

The 430 includes the circuitry necessary to interface an incremental optical Encoder with the Indexer. Dual-channel incremental Encoders with quadrature and with single-ended or square-wave outputs may be used. The Encoder may be used as part of a closed-loop system or as an independent means to verify position. The Encoder may also be used to detect whether a stall has occurred during a move. The functions that are added when Position Tracking is used are:

a. Encoder referenced positioning
b. Encoder position serving
c. Dynamic stall detection
d. Move termination on stall
e. Output signal ON

Except for item e, implementation of the Encoder functions listed above requires connection of the Encoder and setup of the appropriate parameters via the programming inputs.

3.8.2 ENCODER SIGNALS

The Indexer will supply power (up to 1 Amp) to drive an Encoder. Encoder inputs on Terminals 47 to 52 must be 3-29 VDC square wave and TTL compatible. A typical Encoder input circuit was shown in Figure 3-9.

3.8.3 ENCODER SETUP

The Indexer must be supplied with the Encoder parameters before the closed-loop operating modes can be used. See sections 6.8.8 through 6.8.12 for a description of Encoder setup commands.

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A 1,000-line Encoder can be connected directly to a 25,000-step motor (1 to 1 gear ratio). The number of Encoder steps seen by the Indexer is equal to four times the number of Encoder "lines." For example, a 1,000-line Encoder mounted directly on the motor will generate 4,000 Encoder steps for each revolution of the motor shaft. A minimum of two motor steps per Encoder step is required for successful operation of the Position Maintenance function. In the example above, a motor resolution of better than 8,000 steps/rev would be required.

If a reducer is introduced between the motor shaft and the Encoder, the number of Encoder steps must be divided by the equivalent gear ratio to define the number of Encoder steps received by the Indexer.

For example, using a 25,000-step motor, a 1,000-line Encoder, and a 10:1 reducer, the ratio of required motor steps to Encoder steps would be changed as shown below:

Parameter	Encoder Direct Mounted to Motor	10:1 Reducer between Motor and Encoder
Number Encoder steps seen by Indexer per revolution	4,000	400
Required ratio motor steps to Encoder steps	25,000/4,000	25,000/400
Reduced fraction	25/4	125/2

The default values are for a 25,000-step motor and a 1,000-line Encoder. The ratio of motor to encoder steps is controlled with Command **[0176]**. Note that this ratio is expressed as the smallest rational fraction. Refer to section 6.8.8 for further details.

The setup commands (numbered 0176 through 0180) are required to run the 430 in any of its closed-loop operating modes. Default values for the parameters controlled by these commands are loaded into the Indexer at the factory. These default values are set for a 1,000-line Encoder connected directly (1 to 1 gear ratio) to the shaft of a standard 25,000-step motor.

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3.8.4 ENCODER-REFERENCED POSITIONING

The standard 430 normally operates using position parameters in units of motor steps. When Position Tracking is used, the parameters are in units of Encoder steps. In this mode, when making a PRESET move, the Indexer calculates the number of pulses to be sent to the motor based on the Encoder:motor resolution ratio. When Position Tracking is used, closed-loop incremental or absolute moves can be made referenced to Encoder steps using Commands **[0212]** and **[0213]** (see sections 6.8.13 and 6.8.14).

The power-on default position parameters are in units of motor steps. Encoder-referenced positioning is implemented using the closed-loop move commands. (Refer to sections 6.8.5, 6.8.5, 6.8.13, and 6.8.14.)

3.8.5 POSITION MAINTENANCE FUNCTION

The Indexer may be configured to move to a designated Encoder position. In this mode it will resist any spontaneous change in its position when at rest. If external forces cause the Encoder position to change, the Indexer will attempt to correct. This Position Maintenance function is selectable via Command **[0024]** (see section 6.8.11). When this function is selected, the system will attempt to maintain the current Encoder-referenced position. The referenced position is established at the end of each move if this function is turned ON.

When Position Maintenance is enabled only Encoder-referenced moves may be made (see Commands [0212] and [0213]). If it is determined that the Encoder position is not changing in spite of steps sent to the motor, this function will be automatically disabled.

3.8.6 MOTOR STALL DETECTION

When the motor is being moved, the Indexer repeatedly compares the number of Encoder steps coming in against the number of motor steps being sent out

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to verify that no gross discrepancy exists as in the case of a motor stall. If the Encoder position deviates excessively from the desired position in the course of a move, the Indexer assumes the motor has stalled.

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Several configuration options pertain to this feature. These include:

a. Setting the size of a "window" of allowable deviation to account for mechanical backlash and motor wind-up.

b. Terminating the move if a stall is detected.

c. Sending an output signal when a stall occurs.

> Note
>
> Each comparison is independent of the prior one, so that if an allowable error exists every time the comparison is made, no stall is detected. For example, a cumulative error may build up if there is minor slipping in the motor or Encoder coupling.

a. The Deadband Window parameter can be set with Command **[0178]** (see Chapter 6). The deadband is defined in motor steps (number of steps to move load again after a change of direction). Default value is 0. The deadband compensation feature allows mechanical systems with backlash in the gear train to use the Stall Detect and Position Loss Detection features. If a nonzero deadband is selected, the Position Loss Detect and Stall Detect will not be active until the error exceeds the deadband width and the allowable motor wind-up value.

b. The Move Termination on Stall Detect function is selectable via Command **[0025]** (see Chapter 6). If selected, this function will cause termination of a move when a stall is detected, without any delay. This preempts a potentially lengthy correction process cycle when a stall occurs (see Command **[0025]**, Chapter 6).

c. The Output Signal on Stall function is selectable via Command **[0167]** (see Chapter 6). When selected, the output will go low when a stall is detected and remains low until a new move begins.

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3.8.7 TESTING THE ENCODER INTERFACE

Refer to Figure 3-9. Proceed as follows:

a. Connect the incremental optical Encoder to the Indexer.

b. Connect an oscilloscope between Channel A^+ and ground.

c. Slowly rotate the Encoder. The voltage at Channel A^+ should switch between 0 and +5 volts.

d. Transfer the oscilloscope to Channel B^+ and repeat step c.

e. If any of the test point signals do not meet the above requirements, recheck the Encoder connections.

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Chapter 4

FUNCTIONAL AND PERFORMANCE TEST

4.1 GENERAL

The purpose of the tests described in this chapter is to allow the user to verify that Indexer-motor/drive combination is working properly. These tests can be performed in a laboratory or on the production floor.

These procedures are based on the use of the optional Model 431 Manual Programming Unit. These tests can be performed using equivalent BCD thumbwheels and switches or with a set of single throw switches. The functional tests use preprogrammed commands stored in the Indexer permanent (non-volatile) memory. The **EXECUTE TEST MOVE** command ([0255]), which cannot be changed by the user, is described in section 4.3. Three programmed moves and one preprogrammed sequence were loaded into the Indexer at the factory. These moves and sequences, which can be changed by the user, are described in section 4.4.

CAUTION

The test setup will permit you to enter commands. Be careful that you **DO NOT** inadvertently enter a **SAVE PROGRAM** command **[0291]**. The **SAVE PROGRAM** command will transfer the contents of the working (volatile) memory to the permanent memory and erase all prior programming. If the working memory is blank when you use the **SAVE PROGRAM** command, the permanent memory will be erased.

4.2 TEST MOVE

4.2.1 TEST MOVE SETUP

Connect the Model 431 Input Panel or its equivalent, as previously shown in Figure 3-5. Place masking tape on the motor shaft so that shaft motion can be easily observed.

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4.2.2 TEST MOVE COMMAND

If a standard 25,000 step Compumotor motor/drive is connected to the 430, this command will rotate the motor shaft one revolution in a clockwise direction, followed by one revolution in the counterclockwise direction.

When the move is completed, the **STATUS** indicator will change from green to red and Terminal 23 (**ERROR**) will be turned ON. The Indexer must be **RESET** after this test. Proceed as follows:

a. Verify that the motor/drive is properly connected to the Indexer and that the limit switch inputs are grounded.

b. Turn on AC power to the Indexer and the motor/drive.

c. Set the BCD thumbwheels to **0255** to set up the data word.

> Note
> If the Model 431 Input Panel is not used, Terminals 1, 3, 5, 7, and 10 would be connected to ground to form the data word 0255.

d. Press the COMMAND STROBE switch of the 431 to enter the command or momentarily ground Terminal 17.

e. When the test move is complete, momentarily ground Terminal 24 (**RESET**) to restore the Indexer to normal operation.

4.3 PREPROGRAMMED MOVES AND SEQUENCE

> Note
> In the text, where steps have been converted to revolutions, a 25,000-step motor has been used as the reference standard.

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4.3.1 RECALLING THE PROGRAMS

The program for these moves resides in the permanent memory. They can be recalled for operational use with the **RECALL PROGRAM FROM MEMORY** command **[0292]**.

a. Set the BCD thumbwheels to **0292** to set up the data word.

> Note
> Equivalent setting can be obtained by grounding Terminals 2, 5, 8, and 10.

b. Press the COMMAND STROBE switch of the 431 to enter the command.

> Note
> This will copy the program from permanent memory to working memory unless a **SAVE PROGRAM** command has been used that erased the program from permanent memory.

Moves 2, 4, and 8 can be run as part of Sequence 8 (section 4.3.2) or individually (sections 4.3.3, 4.3.4, and 4.3.5).

4.3.2 SEQUENCE NO. 8

The following procedure will run all three moves as part of sequence No. 8. To initiate sequence No. 8, put the temporary jumper to terminal 4 and ground SPECIAL terminal 27.

a. If you want the Indexer to STOP after running Move No. 2 (step 3), ground **TRIGGER 2** (Terminal 40) to set it ON. The sequence will not continue until **TRIGGER 2** is OFF (ungrounded).

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The 430 was programmed at the factory for three moves and one sequence as follows:

Move No. 2 Perform an incremental move. Rotate a distance equal to 107,777 steps (4.3+ revolutions) in a clockwise direction at an acceleration of 1,000,000 steps (40 revs)/sec/sec with a final velocity of 100,000 steps (4 revs)/sec.

Move No. 4 Perform an incremental move. Rotate a distance of 88,888 steps (3.55 revs) in a counterclockwise direction at an acceleration of 700,000 steps (28 revs)/sec/sec and a final velocity of 200,000 steps (8 revs)/sec.

Move No. 8 Perform an absolute move. Move to the zero position established at the last Indexer **RESET** (or **POWER-UP**). Move at a velocity of 150,000 steps (6 revs)/sec and an acceleration of 100,000 steps (revs)/sec/sec.

Sequence No. 8 Move in the following sequence. Repeat the sequence five times unless **TRIGGER 1** is turned on (Terminal 39 grounded).

1- Perform Move No. 2.
2- Pause if **TRIGGER 2** is ON, proceed if (or when) **TRIGGER 2** is OFF.
3- Perform Move No. 4 twice.
4- Pause if **TRIGGER 3** is ON, proceed if (or when) **TRIGGER 3** is OFF.
5- Turn on Programmable Output No. 1 (**OUT1**).
6- Turn on Programmable Output No. 2 (**OUT2**).
7- Wait 2 seconds.
8- Turn off **OUT1** and **OUT2**.
9- Return to the absolute zero (START) position.
10 Repeat the entire sequence five times unless **TRIGGER 1** is turned ON.

Refer to Appendix B for a listing of the 430 codes.

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Note

If the Move No. 8 test is repeated immediately, there will be no apparent motion since the motor is already at the zero position.

4.4 TROUBLESHOOTING THE TEST CONFIGURATION

a. If the move tests above were not successful, recheck the test setup described in section 4.2.1.

b. If the test setup is correct, recall the test program in accordance with section 4.3.1

c. If the problem persists, refer to section 1.5.

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b. If you want to stop the sequence after Move No. 4 has been run twice (step 4), ground **TRIGGER 3** (Terminal 41). The sequence will not continue until **TRIGGER 3** is OFF.

c. If you want to terminate the sequence after step 9, ground **TRIGGER 1** (Terminal 39). The sequence will repeat five times if **TRIGGER 1** is OFF.

4.3.3 MOVE NO. 2 TEST

a. Place a temporary jumper between Terminal 2 (**BIT 1**) and **GROUND**.

b. Momentarily ground Terminal 35 (**START**). The motor shaft will rotate 4.3^{+} revolutions (revs) in a clockwise direction and then stop. When the move is complete, it can be repeated by grounding the **START** input again.

4.3.4 MOVE NO. 4 TEST

a. Transfer the temporary jumper from Terminal 2 to Terminal 3 (**BIT 2**).

b. Momentarily ground Terminal 35 (**START**).

The motor shaft will rotate 3.55 revs in a counterclockwise direction and then stop. The move will be repeated each time **START** is grounded.

4.3.5 MOVE NO. 8 TEST

a. Transfer the temporary jumper from Terminal 3 to Terminal 4 (**BIT 8**).

b. Note the rest position of the motor shaft.

c. Momentarily ground Terminal 35 (**START**). The motor shaft will return to the starting position established when the Indexer was last reset.

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Chapter 5

INDEXER PROGRAMMING AND OPERATION

5.1 OVERVIEW

This chapter describes the command and control inputs and outputs, the basic methods of Indexer operation, and the procedures used to program the Indexer.

There are two basic ways to control the 430:

a. Using signals that drive a few 430 input terminals to ground, or

b. Using commands entered via the 430 parallel or serial input interface.

The term "Discrete Input" is used to identify cases where 430 input terminals other than No. 1 to No. 21 are used for operational control. For example, grounding the **START** input (Terminal 35) to run the default move would be a case where a Discrete Input was used.

A set of commands is required to use all of the 430 capability. The term "BCD Command" is used to identify these commands. The structure of the BCD commands is described later in this chapter. The specific commands are described in detail in Chapter 6.

Note

In this manual BCD Commands are identified with brackets ([]). For example, command number 0020 is shown in the text as [0020].

5.2 COMMAND AND CONTROL INPUTS AND OUTPUTS

Different combinations of inputs and outputs can be used to structure Indexer control configurations that range in complexity from simple single input control to complex automatic systems. The basic command and control

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input/output functions of the Indexer are presented in Figure 5-1 and described in sections 5.2.1 through 5.2.6. Methods of Indexer control using different input configurations are discussed in section 5.3.

5.2.1 LOAD RELATED INPUTS

These optional 430 inputs supply signals to the Indexer that directly or indirectly reflect the position or status of the load. The following inputs are included in the this group:

a. **CW LIMIT** (Terminal 42) and **CCW LIMIT** (Terminal 43). Active high. These inputs must be pulled low to enable Indexer operation (see section 3.6.2.1).

b. **HOME LIMIT** (Terminal 44). Can be set for either low or high true. Default setting is low true (see section 3.6.2.1).

c. **TRIGGER 1** (Terminal 39), **TRIGGER 2** (Terminal 40), and **TRIGGER 3** (Terminal 41). Active low (see section 3.6.2.1).

d. **ENCODER SIGNALS** (47 to 52). Used for position tracking. Direction and Z channel polarity can be changed with internal DIP switches (see section 3.6.3).

The first two inputs (items a and b) are provided by load-activated switches and provide a state change when an event has occurred. The TRIGGER inputs are user-defined signals that are generally used to synchronize Indexer operation with external events. The Encoder signal is a variable number of pulses (number of steps) that is related to the position of the load or the motor shaft, depending upon the specific operational mode selected.

5.2.2 SERIAL INTERFACE INPUTS

The connections for this interface are described in detail in section 3.6. Sets of ASCII characters in a specified message format are transmitted from a terminal or computer to the Indexer for subsequent processing (see section 5.4.4).

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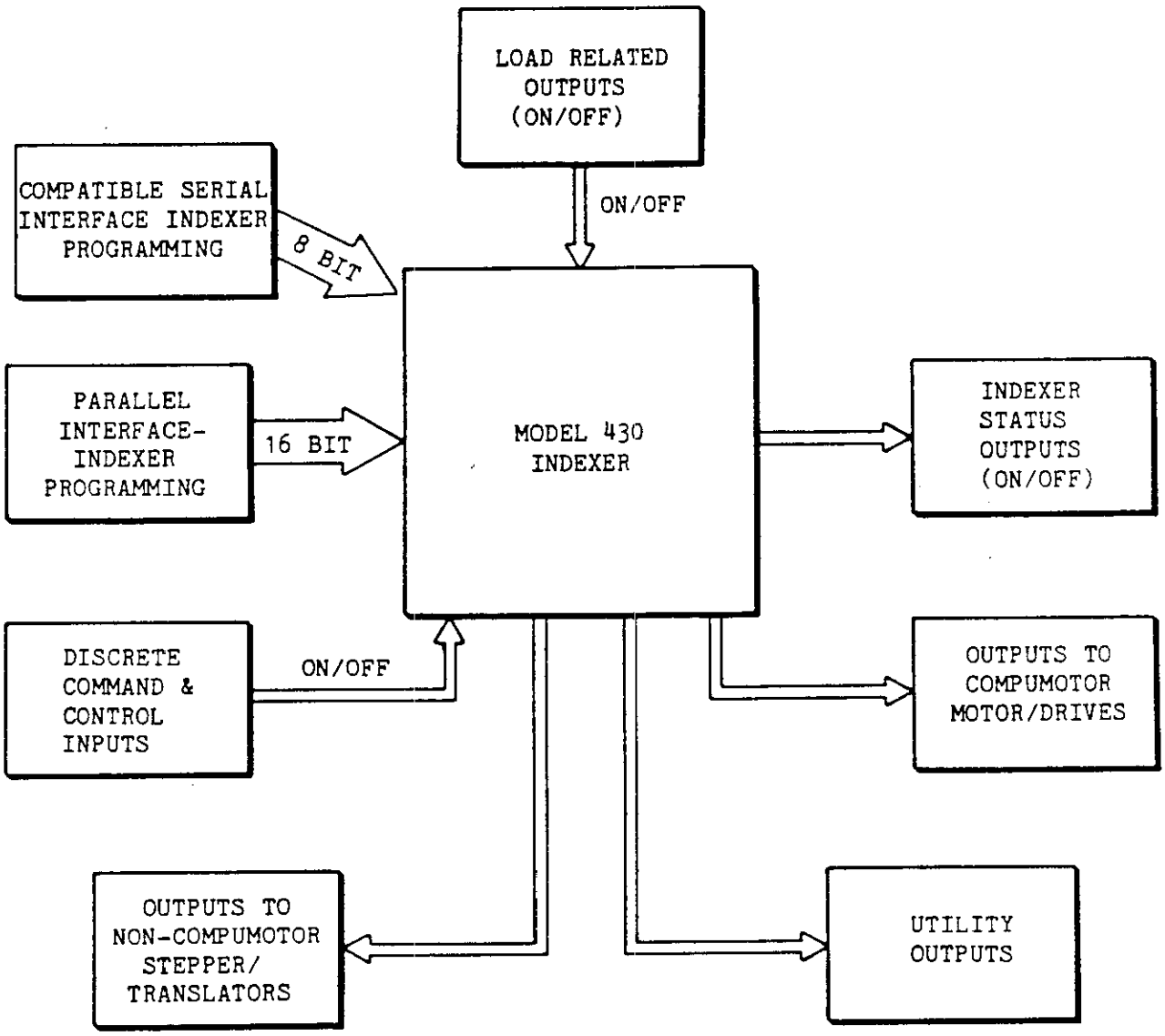


Figure 5-1. Basic Command and Control Input/Output Functions

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5.2.3 PARALLEL INTERFACE INPUTS

The parallel interface consists of 16 data inputs (Terminals 1 through 16) and five strobe inputs (**COMMAND STROBE, DATA STROBE 1, DATA STROBE 2, DATA STROBE 3,** and **DATA STROBE 4**) that are used to control how the Indexer interprets the 16 data inputs. The polarity of these inputs can be set with internal DIP switches to be either low or high true. The factory setting is low true. The optional Model 431 Input Panel can be connected to these inputs for manual programming of the Indexer. Refer to section 5.3 for a detailed description of the use of these inputs.

5.2.4 DISCRETE INPUTS

These inputs control a variety of functions and include **STOP, START, DIRECTION, PRESET, ABSOLUTE, JOG, OUTDISABLE, RESET, SPECIAL,** and **GO HOME.** Refer to section 3.6.1 for a hardware description of these 430 inputs.

5.2.4.1 **Start and Stop Shaft Motion -- START (Terminal 35) and STOP (Terminal 33).**

START: MULTIFUNCTION INPUT

a. Initiate Default Move - If the signals on Terminals 1 to 16 equal a BCD zero, a low signal on this input initiates a move using the currently defined acceleration and velocity values plus the parameters defined by Terminals 36 (**DIRECTION**), 37 (**PRESET**), and 38 (**ABSOLUTE**).

b. Initiate Predefined Move - If the signals on Terminals 1 to 16 represent a BCD number between 1 and 40, and a PREDEFINED MOVE with that number assigned is stored in working memory, a low signal on this input will initiate that PREDEFINED MOVE. In this mode the state of Terminals 36, 37, and 38 does not affect the move (refer to Chapter 5).

c. Initiate Serial Programming Mode - If **STOP** (Terminal 33) and START (Terminal 35) are grounded, the Indexer is in the Serial Programming Mode. See section 3.6.2.3 for additional details.

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STOP will decelerate the motor at a rate equal to the last acceleration rate used. If a PREDEFINED SEQUENCE is in progress (see section 6.1.2), **STOP** will terminate the sequence.

5.2.4.2 **Setup Default Move Parameters -- DIRECTION (Terminal 36), PRESET (Terminal 37), and ABSOLUTE (Terminal 38).** The Indexer can be operated with a set of default move parameters. The default move parameters include acceleration, velocity, distance, direction, and type of move. Acceleration, velocity, and distance can be set with either the internal DIP switches or by a command. **DIRECTION, PRESET,** and **ABSOLUTE** are used to set the default values for direction and type of motion.

DIRECTION If ungrounded (input high), the motor shaft will rotate in clockwise direction. If input grounded, the motor shaft will rotate in counterclockwise direction.

PRESET If ungrounded (input high), the default move will be CONTINUOUS. If input grounded (low), the motor shaft will move a preset distance whose value is set by the default parameters.

ABSOLUTE If ungrounded (input high), the default position parameter will be interpreted by the Indexer as an incremental distance. If input grounded (low), the default position parameter will be interpreted as an ABSOLUTE move from zero. (See also section 6.6.2.3.)

5.2.4.3 **Jog Motion Inputs -- JOG + (Terminal 25), and JOG - (Terminal 26).**

JOG + If grounded (low), will cause the motor shaft to move in clockwise direction at the presently defined JOG velocity (default value = 2,500 steps/sec) and acceleration. Input ungrounded (high) stops the JOG motion.

JOG - If grounded (low), will cause the motor shaft to move in counterclockwise direction at the presently defined JOG velocity (default value = 2,500 steps/sec) and acceleration. Input ungrounded (high) stops the JOG motion.

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5.2.4.4 **Enable/Disable Output Signals — OUT(PUT) DISABLE (Terminal 29).** If ungrounded (high), four outputs (**ERROR, READY, OUT1, OUT2**) are enabled. If this input grounded (low), all four outputs are disabled. When multiple Indexers are controlled by a single controller, this feature allows one unit at a time to report status.

5.2.4.5 **Reset Indexer — RESET (Terminal 24).** If this input is grounded momentarily, the Indexer will act as though AC power had been shut off and been turned back on. If this input is held low, the Indexer is disabled.

5.2.4.6 **Special Assignment Command — SPECIAL (Terminal 27).** This input may be assigned to any command in the command library using Command [0301]. When the input is grounded (low), the Indexer will execute the assigned command, or if no assignment has been made, the Indexer will execute the default command assignment. The default assignment is to perform a sequence (equivalent of Command [0065]). The number of the sequence to be executed is read from the command data inputs (Terminals 1 through 16). No action will occur if the preprogrammed sequence is not stored in working memory.

5.2.4.7 **GO HOME (Terminal 34).** If input grounded (low) and the motor stopped, the Indexer will execute an open-loop **GO HOME** command using the presently defined go home parameters (see command [0056], section 6.3.5). If Position Tracking is enabled (closed-loop operation), the Indexer will execute a **GO TO CLOSED LOOP HOME** Command (see section 6.6.3.1). The initial **HOME** search direction is determined by the status of the direction input (Terminal 36).

5.2.4.8 **Shut OFF Motor Current — Shut Down (Terminal 32).** If the input is grounded (low), current to motor is shut OFF, which eliminates motor torque. This input can be disabled with Command [0019].

5.2.5 *INDEXER STATUS OUTPUTS*

Four Indexer status outputs are available: **READY** (Terminal 28), **ERROR** (Terminal 23), **OUT1** (Terminal 30), **OUT2** (Terminal 31). These outputs go low when they are active. Refer to section 3.6.2 for hardware descriptions of these outputs.

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READY If this output is active (low), the Indexer is ready to accept another command. The ready status is updated every 2 milliseconds. This output also can be used to echo characters when the serial programming mode is used.

ERROR If this output is active (low), an error has occurred which could prevent receipt of a command. Time delay between occurrence of an error and the output going active is 80 microseconds. Error could be minor or major. **SAVE** (see Chapter 6) any moves or sequences that have not been previously saved and RESET Indexer to clear error.

OUT1/OUT2 Programmable outputs that can be used to indicate status or drive external equipment. Outputs may be set ON or OFF.

5.2.6 MOTOR/DRIVE OUTPUTS

Terminals 61 through 66 carry the signals to drive Compumotor motor/drives. These outputs may be configured for single-ended or differential outputs if a Compumotor motor/driver is not used.

Terminals 59 (**CW STEP**) and 60 (**CCW STEP**) provide signals to drive non-Compumotor stepper translators. (See section 3.6 for signal descriptions).

5.2.7 UTILITY OUTPUTS

A common signal **GROUND** is provided at Terminal 22. A +5 VDC supply voltage is available on Terminal 45. This supply will provide up to 1 Amp service, which is sufficient for most incremental encoders.

Terminal 46 (**PULLUPS**) provides a means to pull the four Indexer status outputs (see section 5.2.5) to a high (30 VDC maximum) level.

5.3 BASIC METHODS OF OPERATION

Three basic methods of operation (Unprogrammed Operation, Preprogrammed Operation and Dynamically Programmed Operation) are available as described

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in sections 5.3.1, 5.3.2 and 5.3.3. Three types of procedures based on the three methods of operations can be used as follows:

a. Manual procedures based on either Unprogrammed Operation or Preprogrammed Operation.

b. Semi-automatic or automatic procedures using discrete inputs or a programmable controller in combination with Preprogrammed Operations.

c. Automatic interactive procedures using a combination of Dynamically Programmed Operations and an on-line programmable controller.

5.3.1 NONPROGRAMMED OPERATION

The Indexer can be set up for a single move pattern using the internal DIP switches (see section 3.7) and the Front Panel discretes described in section 5.2.4. After setup, wire jumpers or switches can be connected to the front face of the unit for local operation. While relatively easy to set up, Nonprogrammed Operation does not take full advantage of the 430 capabilities.

5.3.2 PREPROGRAMMED OPERATION

The Indexer can be preprogrammed for multiple moves. Preprogrammed Operation allows full use of the 430 capabilities. The unit can be programmed manually via the optional Model 431 Input Panel, via a serial interface and terminal or computer, or via a 16-bit parallel interface and programmable controller. After programming is complete, the unit can be operated manually or controlled by a programmable controller. Up to 40 different moves and 15 different combinations of moves and commands (called sequences) can be preprogrammed. After programming is complete, a programmable controller or discrete controls can be used to access any move or sequence for floor operations.

Figure 5-2 illustrates an example of an application where preprogrammed sequences and moves are used in conjunction with Discrete Inputs. In this

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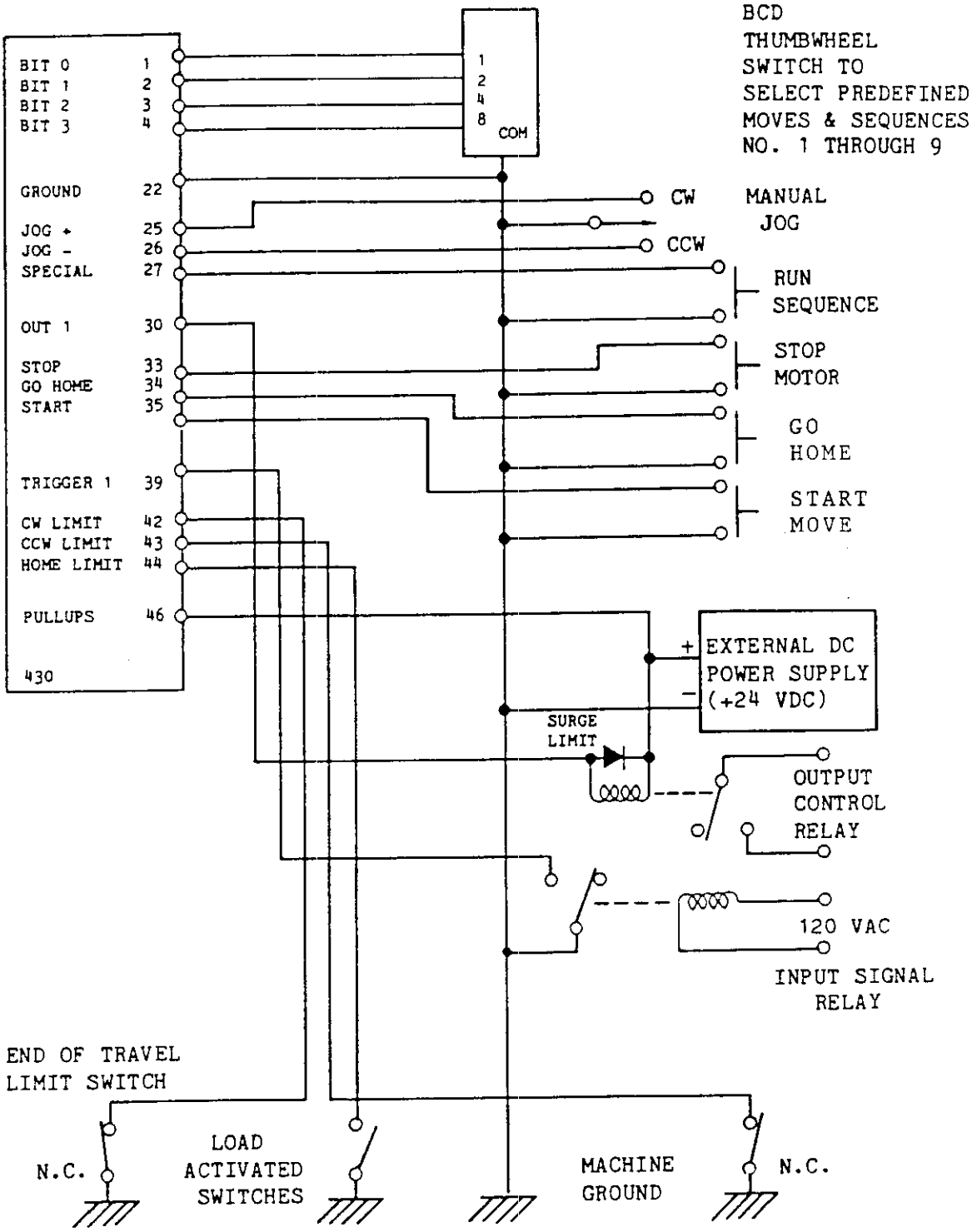


Figure 5-2. Application Example -- Sequences Plus Discrete Input

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example, one BCD thumbwheel is used to identify the sequence number. Alternatively, temporary jumpers or single-pole, single-throw switches could be used for this function.

Preprogrammed Operation using the Serial Programming Mode with a computer or terminal requires the use of the computer or terminal only during the programming procedure. A parallel interface (16 data bits plus 5 discrete strobes) is used for programming via a programmable controller. When the serial interface is used to program the Indexer, no other operations can be executed during the programming procedure. When the parallel interface is used to program the unit, other commands can be executed.

5.3.3 DYNAMICALLY PROGRAMMED OPERATION

The Indexer can be dynamically programmed by a programmable controller while executing previously programmed commands. Dynamically Programmed Operation allows full use of the 430 capabilities and has the potential for interactive on-line operation. The programmable controller must have the capability to drive the 16 430 data inputs and the 5 430 strobe inputs.

5.4 PROGRAMMING THE INDEXER

5.4.1 GENERAL

The Indexer is equipped with two types of internal memories to store data and commands:

a. A working (volatile) memory that does not retain data when the Indexer is turned OFF. During normal operations the Indexer refers to this memory for commands, moves, and sequences.

b. A permanent (non-volatile) memory that retains data and commands when the Indexer is turned OFF. This memory is used only for storing of commands, moves, and sequences. The contents of this memory must be copied into the working memory (recalled) before the Indexer can use the stored information.

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The relationship between the contents of the two memories is shown in Figure 5-3. The internal DIP switches are manually set. The data registers can be set only by externally generated inputs.

5.4.2 STRUCTURE OF MODEL 430 COMMANDS

430 commands are represented by Binary Coded Decimal (BCD) digits. A BCD digit can have any value from 0 to 9. A combination of four binary characters called "bits" are used to define a BCD digit. (A binary input can have only one of two states, such as on/off or zero/one.) Each bit is assigned the value of zero or OFF when inactive (OFF) and a specific BCD value when active (ON), as follows:

	OFF	ON
BIT 1	0	1
BIT 2	0	2
BIT 3	0	4
BIT 4	0	8

The binary inputs are summed to define the desired decimal value. For example, the bit pattern for the decimal value of 7 would be

	STATUS	VALUE INDICATED
BIT 1	ON	1
BIT 2	ON	2
BIT 3	ON	4
BIT 4	OFF	0
	TOTAL	7

Similarly, for a desired decimal value of 9, the bit combination would be

	STATUS	VALUE INDICATED
BIT 1	ON	1
BIT 2	OFF	0
BIT 3	OFF	0
BIT 4	ON	8
	TOTAL	9

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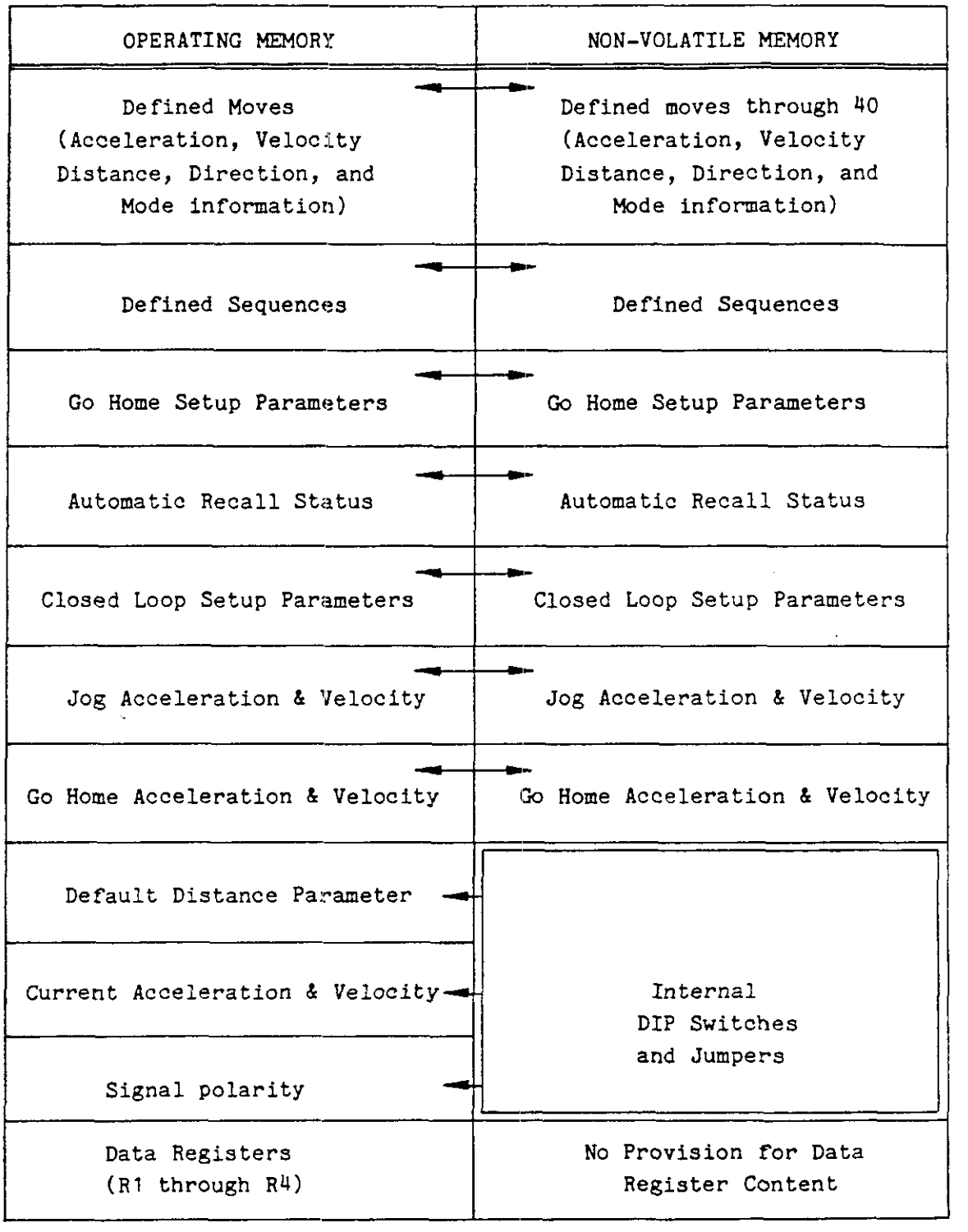


Figure 5-3. Model 430 Data Memory Organization

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When BCD digits are used, indicated values greater than 9 are treated as invalid amounts.

All 430 commands are identified with a four-digit BCD combination (word) such as [0024], [0222], [0115], etc. Some, but not all, commands also require from one to four supporting four-digit BCD data words to fully describe the command.

All externally generated BCD data is initially stored in a set of internal buffers called registers. Four data registers and a command (identification) register are used. The command entry process described in sections 5.4.3 and 5.4.4 identifies what information is to be entered into each of the registers and when the command entry is complete. Subsequently, the 430 transfers the contents of the registers into working memory for further processing. Externally generated commands can be entered via the parallel interface (section 5.4.3) or the serial interface (section 5.4.4).

Each four-digit register can store a number between 0 and 9,999. If the value of the data required to support a particular command exceeds 9,999, multiple four-digit registers are used to define the value. For example, if the number 12,167 is required for a command, the register assignment used to represent the value would be

Register 1 = $d_4d_3d_2d_1$ = **2 1 6 7**

Register 2 = $d_8d_7d_6d_5$ = **0 0 0 1**

The two registers would be summed as follows:

	BCD DIGIT	VALUE OF BCD DIGIT	ASSIGNED VALUE X MULTIPLIER
Register 1	d_1 =	7	(7 x 1)
	d_2 =	60	(6 x 10)
	d_3 =	100	(1 x 100)
	d_4 =	2,000	(2 x 1,000)
Register 2	d_5 =	10,000	(1 x 10,000)
	d_6 =	0	(0 x 100,000)
	d_7 =	0	(0 x 1,000,000)
	d_8 =	0	(0 x 10,000,000)
	Sum =	12,167	

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Specific register assignments, which vary from command to command, are described in Chapter 6.

5.4.3 PARALLEL INTERFACE COMMAND ENTRY

The Indexer is normally configured for this mode of operation. Other operations and processes can occur when this mode is being used. Terminals 1 through 21 are the inputs for the parallel interface (see Figure 5-4). Terminals 1 through 16 define the BCD words, as shown in Figure 5-4A. Terminals 17 through 21, which are shown in Figure 5-4B, are the "strobe" inputs used to enter the BCD words into the proper register. Data words are identified by different strobes as part of the entry process. Therefore, the order of entry of the data words is not important. In addition, you need only make entries for the specific registers associated with the command you are entering.

> Note
>
> To avoid mistakes, the use of a consistent systematic procedure for the entry of data words is recommended. The form shown in Figure 5-5 can be used to assist you in this process.

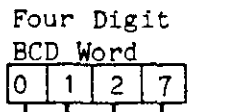
When the Command strobe is activated, the Indexer accepts the current BCD word setup on Terminals 1 through 16 as the command identification. In addition, the Indexer accepts the current contents of the data registers associated with the specific command as the valid data for the command being entered. Therefore, the data words must be correctly entered before the Command strobe is activated. The recommended sequence for entering specific commands is included in the summary command tables of Chapter 6.

5.4.4 SERIAL INTERFACE COMMAND ENTRY

Command entry in this mode differs from the process used for command entry via the parallel interface in several important ways, as follows:

a. The serial input mode precludes any other operation during the period when the mode is active.

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Digit Designation		BCD DIGITS Binary BIT Assignment	Assigned Value	430 Terminal No.
LEAST SIGNIFICANT DIGIT (LSD)	1	BIT 0	1	1
		BIT 1	2	2
		BIT 2	4	3
		BIT 3	8	4
	2	BIT 4	10	5
		BIT 5	20	6
		BIT 6	40	7
		BIT 7	80	8
	3	BIT 8	100	9
		BIT 9	200	10
		BIT 10	400	11
		BIT 11	800	12
MOST SIGNIFICANT DIGIT (MSD)	4	BIT 12	1000	13
		BIT 13	2000	14
		BIT 14	4000	15
		BIT 15	8000	16

(Maximum BCD Value - 9999)

STROBES

Name	Terminal
Command Strobe 1	17
Data Strobe 1	18
Data Strobe 2	19
Data Strobe 3	20
Data Strobe 4	21

Figure 5-4. Parallel Interface

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Program name:_____ Date:__/__/__

Enter the commands, and required data for each command, below:

	Command Name	Data Reg. 1	Data Reg. 2	Data Reg. 3	Data Reg. 4	Command No.
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						

Figure 5-5. Indexer Command Language Sheet

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b. Data words must be entered in a specific order and entries are required for all registers.

c. The Indexer must be configured for the serial input mode as described in section 3.6.2.

To activate the Serial Programming Mode,

>> Connect the 430 to the host per section 3.6.2.3 (Figure 3-8).
>> Ground the **START** and **STOP** terminal.

To exit the Serial Programming Mode,

>> Unground the **START** and **STOP** terminal.
>> Transmit one additional ASCII character to the Indexer or momentarily ground the **ABSOLUTE** input terminal.

The data format for entering commands is fixed and inflexible. For each command entry using the serial input mode, the Indexer requires five BCD words. These BCD words correspond to the data for Registers 1 through 4 and the command identification number and must be entered in that order. Each of the words may consist of one to four digits in the range of 0 to 9,999. The leading 0s need not be entered. (For example, 0004 would be entered as 4. and 0240 would be entered as 240.) Data words for each register must be included as part of the command entry even if the command requires no data.

Spaces (delimiters) are used to indicate when a word ends. These spaces must be inserted between the data words. A carriage return instead of the command strobe is used to indicate that the command entry is complete. If the numbers preceding the carriage return do not conform to the above format, the entire command entry will be rejected. The first character of the command entry must not be preceded by any spaces. The carriage return must not be accompanied by a "line feed" character. Some terminals have a function called "auto line feed press," which sends a line feed character with each carriage return when you press the RETURN key. This function must be disabled.

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An example of a command entry line via the serial input mode using Command [0200] (section 6.7.1.1), which is intended to define Move Number 7 to be 118,750 motor steps in the counterclockwise direction, would be

7 100 11 8750 200<CR> (**<CR>** = carriage return)

This corresponds to entering the following data and command in the parallel format:

R1	R2	R3	R4	Command
0007	0100	0011	8750	0200

To enter a command that does not require any supporting data words such as Command [0292], **RECALL PROGRAM FROM MEMORY** (section 6.7.4), the command line would be

0 0 0 0 292<CR>

For computer owners, several BASIC language programs are available from Compumotor to facilitate generating, storing, and transmitting programs for the 430. Programs sent by a computer must incorporate a 10-millisecond delay between commands to give the 430 time to process them. The **SAVE PROGRAM**, **RECALL PROGRAM FROM MEMORY**, and **AUTORECALL ON POWER UP** commands take longer.

5.5 CALLING, STORING AND CHANGING PROGRAMS

5.5.1 AUTORECALL/RECALL

The optional **AUTORECALL ON POWER-UP** capability can be used to automatically copy the information from permanent memory to working memory each time the Indexer is turned ON (powered-up) or RESET. (See section 6.9.5 for **AUTORECALL ON POWER-UP** details). Recall can be obtained by manually entering the **RECALL PROGRAM FROM MEMORY** command via the parallel or serial interface. (See section 6.9.4 for **RECALL PROGRAM FROM MEMORY** details).

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a. To use the Model 431 for the **ENABLE AUTORECALL ON POWER-UP** command,

>> Set the thumbwheel switches to **0001** (0000 = function off)
>> Press ***DS2*** (Data Strobe 2)
>> Set the thumbwheels switches to **0293**
>> Press **CMD STB** (Command Strobe)

b. To use the Model 431 for the **RECALL PROGRAM FROM MEMORY** command,

>> Set the thumbwheel switches to **0292**
>> Press **CMD STB**

c. To enter the **ENABLE AUTORECALL ON POWER-UP** command via the serial interface,

>> Activate the serial interface
>> Enter the following command line

0 1 0 0 293<CR> (0000293 = function OFF)

d. To enter the **RECALL PROGRAM FROM MEMORY** command via the serial interface

>> Activate the serial interface
>> Enter the following command line

0 0 0 0 292<CR>

5.5.2 SAVE

Externally generated program commands are initially entered into working memory. The contents of working memory can be copied to permanent memory using the SAVE command.

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CAUTION

You need to be very careful when you use the **SAVE PROGRAM** command to avoid unintentional changes of the information stored in permanent memory. **SAVE PROGRAM** changes the entire contents of permanent memory to match the current contents of the working memory (see section 6.9.3). If working memory is blank, **SAVE PROGRAM** will blank the permanent memory.

a. To change an existing stored program

>> **RECALL PROGRAM FROM MEMORY** the contents of the permanent memory to working memory

>> Enter the changes you want to make using the Model 431 Input Panel or the serial interface

>> Enter the **SAVE PROGRAM** command

(0292 plus **CMD STB** via 431)

0 0 0 0 292<CR> (via serial interface)

Note

The safest way to approach the **SAVE PROGRAM** operation is to **RECALL** the contents of permanent memory, make any desired changes to the existing information, add any new information and then **SAVE** the contents of working memory.

The contents of working memory may be examined if the **LIST PROGRAM** command (command [0311]) is used. This command will cause the 430 to transmit a listing of PREDEFINED MOVES and PREDEFINED SEQUENCES.

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b. To replace the contents of permanent memory with a copy of the current contents of working memory, enter the **SAVE PROGRAM** command as noted above.

Note

If you inadvertently lose programs through the use of **SAVE PROGRAM**, you will have to reenter the lost information into working memory and then **SAVE** the new information.

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Chapter 6

INDEXER COMMANDS

6.1 OVERVIEW

This chapter describes the BCD commands that are used to program and/or control the Indexer. All of the commands described in this chapter are entered via the parallel or serial interface.

For ease of use and presentation, the 430 commands are subdivided into the following functional groups:

a. Shaft Motion Setup Commands (Table 6-1, page 6-6)
b. Position Description Commands (Table 6-2, page 6-7)
c. Execute or Continue Execution Commands (Table 6-3, page 6-8)
d. Stop or Pause Commands (Table 6-4, page 6-9)
e. Position Tracking Commands (Table 6-5, page 6-11)
f. Programming and Store Commands (Table 6-6, page 6-13)
g. General Purpose Commands (Table 6-7, page 6-14)

These functional groups are presented in summary form in section 6.2 in the tables indicated above. Each table references the section that describes the listed command in detail. In addition, an alphabetical and numerical listing of the commands is included at the end of the chapter.

6.1.1 CONVENTIONS USED IN TEXT

All BCD commands are identified by a four-digit decimal whole number; for example, 0120, 0055, 0301, etc. The command identification number is highlighted in the text with brackets, []; for example, [0201], [0022], and [0014]. These brackets are for illustrative purposes only and are not recognized by the Indexer as part of the command identification. These brackets are not part of the command and should not be entered when commands are entered.

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Some of the commands are fully defined by the four-digit identification number. In many cases, additional data entry is required to fully define the command is shown in the text by the notation

[0217](dddd)

where (dddd) represents the data required and d is a number between 0 and 9. The text body indicates the exact number of digits in the data word. If more than one data word is required, this is also shown in the text; for example

[0056](0ddd)(0bbb)

where d indicates the required value of a number from 0 to 9 and b indicates a "0" or a "1" is required in other than a value between 0 and 9.

Note

To conserve space, an abbreviated form of this notation is used in Tables 6-1 through 6-7. In the example above the notation would be shown as [0056]().

Commands that are dependent upon other commands are flagged with an ampersand (&); for example,

[0065](00ddd)&

Note

In Tables 6-1 through 6-7 the associated commands are also indicated in column 1. In the example above, the entry is [0065]( )& [0216], [0217].

6.1.2 COMBINATIONS OF BCD COMMANDS

430 commands with the proper attributes (see section 6.1.3) can be stored as part of a set of commands that define a move or sequence of moves. The definitions that follow apply to command combinations.

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PREDEFINED MOVE: A combination of individual BCD commands that define a single move. A PREDEFINED MOVE cannot include another PREDEFINED MOVE or PREDEFINED SEQUENCE.

PREDEFINED SEQUENCE: A combination of individual BCD commands including one or more PREDEFINED MOVE commands. A PREDEFINED SEQUENCE cannot include other PREDEFINED SEQUENCES.

The Indexer can store 40 PREDEFINED MOVES and 15 PREDEFINED SEQUENCES.

6.1.3 DEFINITION OF COMMAND ATTRIBUTES

Command attributes define the operational use and priority of the commands. The 430 commands can have one or more of the following attributes:

SEQUENTIAL: BCD commands that can be stored as part of a PREDEFINED SEQUENCE. Indicated by (Seq) in the summary command tables.

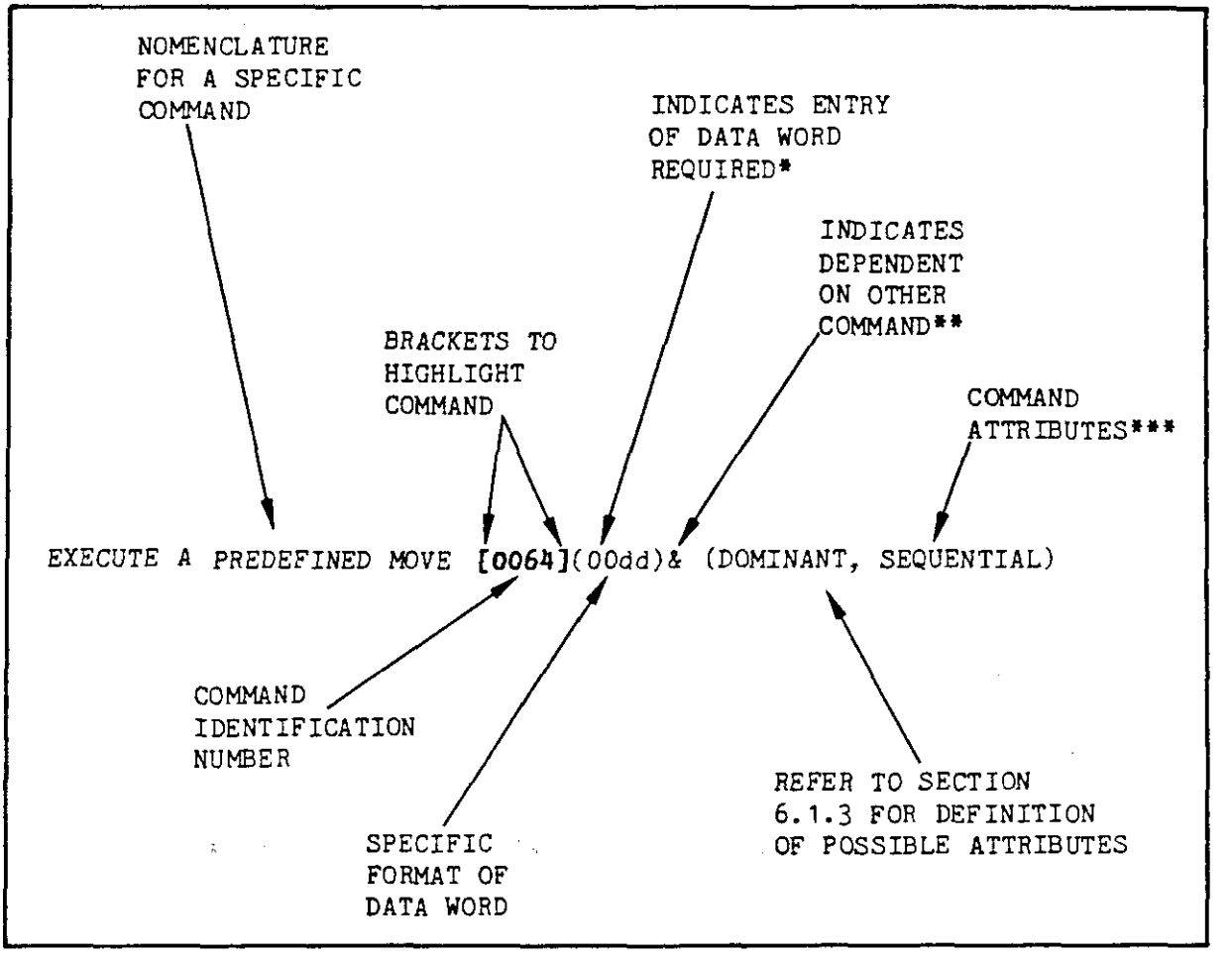
IMMEDIATE: Priority commands that are immediately executed whenever they are entered via the Parallel Interface. When these commands are included as part of a PREDEFINED SEQUENCE, they do not have any special priority. Indicated by (Imm) in the summary command table.

DOMINANT: Commands that must be completed before another sequential command can be executed. IMMEDIATE commands can be executed concurrently with DOMINANT commands. Indicated by (Dom) in the summary command tables.

DELAYED ACTION: Commands that are dependent upon an external input or event to complete execution of the command. Indicated by (Dly) in the summary command tables.

The conventions used in the text are summarized in Figure 6-1.

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*Shown in Tables 6-1 through 6-7 by ( )

**Shown in Tables 6-1 through 6-7 with identification number of associated commands (e.g., & 0200 to 0213)

***Shown in abbreviated form in Tables 6-1 through 6-7 (e.g., Dom, Seq)

Figure 6-1. Conventions Used to Describe 430 BCD Commands

6.2 SUMMARY COMMAND TABLES

Each table presents individual 430 BCD commands in summary form. The recommended sequence for entry of associated data word is included in these tables. (See Chapter 5 for a discussion of data words.) The format for the summary command table is detailed in Figure 6-2.

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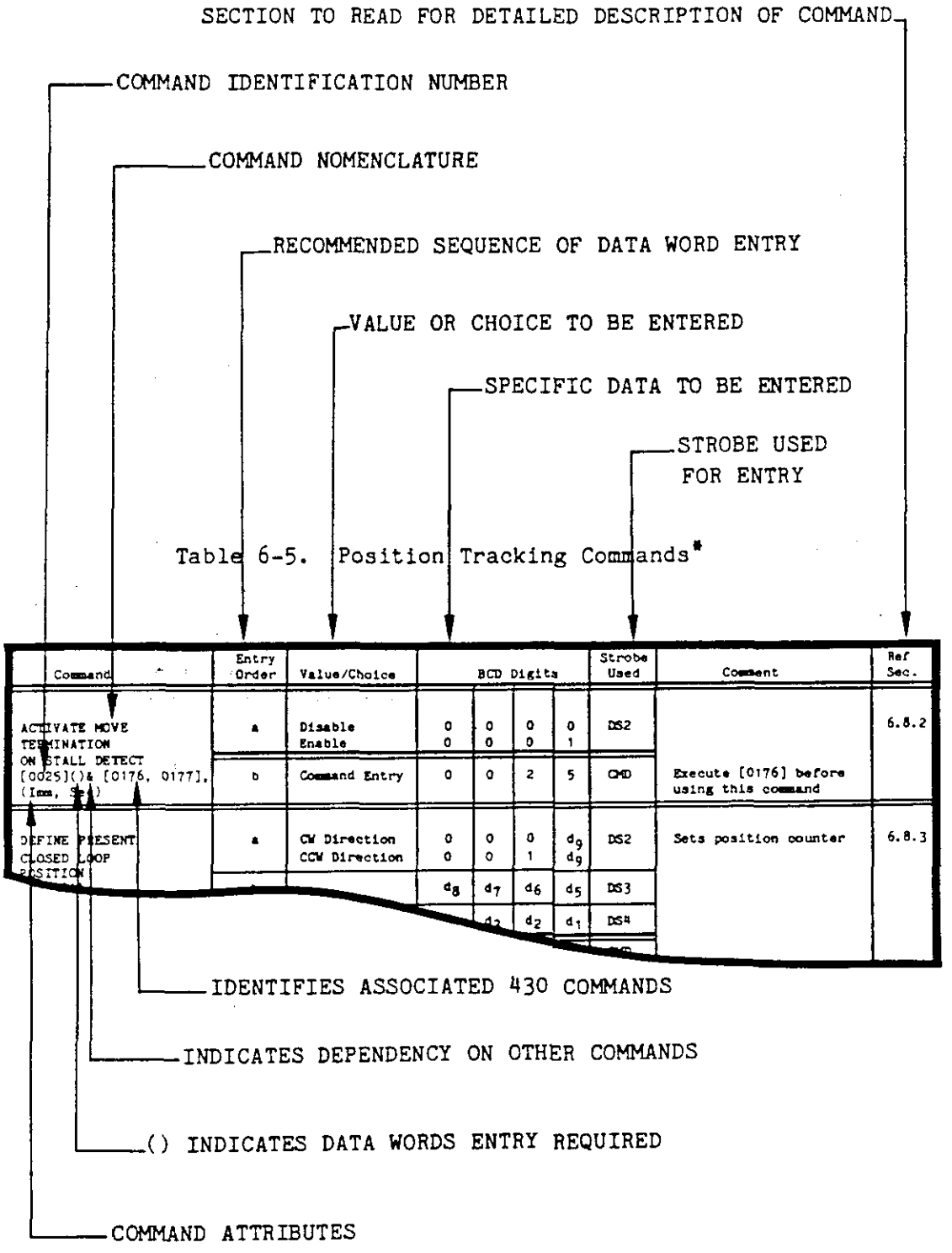


Table 6-5. Position Tracking Commands*

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
ACTIVATE MOVE TERMINATION ON STALL DETECT [0025]()& [0176, 0177], (Imm, Sta)	a	Disable Enable	0 0	0 0	0 0	0 1	DS2		6.8.2
	b	Command Entry	0	0	2	5	CMD	Execute [0176] before using this command	
DEFINE PRESENT CLOSED LOOP POSITION	a	CW Direction CCW Direction	0 0	0 0	0 1	d_9 d_9	DS2	Sets position counter	6.8.3
			d_8	d_7	d_6	d_5	DS3		
				d_3	d_2	d_1	DS4		

Figure 6-2. Explanation of Summary Command Table Format

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Table 6-1. Shaft Motion Setup Commands

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
SET MOVE DIRECTION [0020]() (Imm,Seq)	a	CW CCW	0 0	0 0	0 0	0 1	DS2	Reverses direction set by Term 36. Reverts to CW after RESET	6.4.1
	b	Command Entry	0	0	2	0	CMD		
SET START/STOP VELOCITY [0214]() (Imm)	a	$d_{10}d_9$	0	0	d_{10}	d_9	DS2	Part of all moves except final approach portion of GO HOME operation. Define as zero after RESET	6.4.2
	b	$d_8d_7d_6d_5$	d_8	d_7	d_6	d_5	DS3		
	c	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	d	Command Entry	0	2	1	4	CMD		
SET VELOCITY [0261]() (Imm,Seq)	a	Range steps/sec /10 sec /100 sec /1000 sec /min /sec	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 1 2 3 4 5	DS1	Applies for all moves except JOG and GO HOME, which can be separately set Default value set with internal DIP switches	6.4.3
	b	$d_{10}d_9$	0	0	d_{10}	d_9	DS2		
	c	$d_8d_7d_6d_5$	d_8	d_7	d_7	d_6	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	6	1	CMD		
SET ACCELERATION [0262]() (Imm, Seq)	a	Range /sec /10 sec /100 sec	0 0 0	0 0 0	0 0 0	0 1 2	D1	Applies for all moves except JOG and GO HOME, which can be separately set Default value set with internal DIP switches	6.4.4
	b	$d_{10}d_9$	0	0	d_{10}	d_9	DS2		
	c	$d_8d_7d_6d_5$	d_8	d_7	d_7	d_6	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	6	2	CMD		
SET JOG VELOCITY [0281]() (Imm,Seq)	a	Range steps/sec /10 sec /100 sec /1000 sec /min / 1/2 sec	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 1 2 3 4 5	DS1	Sets value for JOG [0283] Applies to JOG moves only Default value: 2,500 steps/sec	6.4.5
	b	$d_{10}d_9$	0	0	d_{10}	d_9	DS2		
	c	$d_8d_7d_6d_5$	d_8	d_7	d_7	d_6	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	8	1	CMD		
SET JOG ACCELERATION [0282]() (Imm, Seq)	a	Range /sec /10 sec /100 sec	0 0 0	0 0 0	0 0 0	0 1 2	D1	Sets value for JOG [0283] Applies to JOG move only Maximum value is default value	6.4.6
	b	$d_{10}d_9$	0	0	d_{10}	d_9	DS2		
	c	$d_8d_7d_6d_5$	d_8	d_7	d_7	d_6	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	8	2	CMD		

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Table 6-1. Shaft Motion Setup Commands (Continued)

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
SET GO HOME VELOCITY [0284]() (Imm,Seq)	a	Range							6.4.7
		steps/sec	0	0	0	0	DS1	Normal velocity parameters serve as default values	
		/10 sec	0	0	0	1			
		/100 sec	0	0	0	2			
		/1000 sec	0	0	0	3			
		/min	0	0	0	4			
		/1/2 sec	0	0	0	5			
	b	$d_{10}d_9$	0	0	d_{10}	d_9	DS2		
	c	$d_8d_7d_6d_5$	d_8	d_7	d_7	d_6	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	8	4	CMD		
SET GO HOME ACCELERATION [0285]() (Imm, Seq)	a	Range							6.4.8
		/sec	0	0	0	0	D1	Normal velocity parameters serve as default values	
		/10 sec	0	0	0	1			
		/100 sec	0	0	0	2			
	b	$d_{10}d_9$	0	0	d_{10}	d_9	DS2		
	c	$d_8d_7d_6d_5$	d_8	d_7	d_7	d_6	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	8	5	CMD		

Table 6-2. Position Definition Commands

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
SET OFFSET FROM ZERO [0046]() (Imm,Seq)	a	CW Direction	0	0	0	d_9	DS2	Sets the position counter	6.5.1
		CCW Direction	0	0	1	d_9			
	b		d_8	d_7	d_6	d_5	DS3		
	c		d_4	d_3	d_2	d_1	DS4		
	d	Command Entry	0	0	4	6	CMD		
SET PRESENT POSITION AS ABSOLUTE ZERO POSITION [0048]() (Imm,Seq)	a	Command Entry	0	0	4	8	CMD	Zeros the position counter	6.5.2
DEFINE HOME [0056]() (Imm)	a	Approach Vel.	0	d_3	d_2	d_1	DS1	% HOME Velocity (1 to 100)	6.5.3
	b	Conditions	0	b_3	b_2	b_1	DS2	Refer to text for states and description	
	c	Command Entry	0	0	5	6	CMD		

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Table 6-3. Execute or Continue Commands

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
EXECUTE LOOP [0032]() (Seq)	a	Number Commands	0	d_3	d_2	d_1	DS1	Maximum of 255 commands	6.6.1.1
	b	Number Repeats	0	0	0	d_5	DS2	Maximum number of repeats: 65,535	
	c		d_4	d_3	d_2	d_1	DS3		
	d	Command Entry	0	0	3	2	CMD		
EXECUTE LOOP UNTIL *CONTINUE* [0033]()& [0072] (Seq)	a	Number Commands	0	d_3	d_2	d_1	DS1	Maximum of 255 commands Continue [0072] terminates loop	6.6.1.2
	b	Command Entry	0	0	3	3	CMD		
EXECUTE CONTINUOUS MOVE [0050]()& [0261, 0262], (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 0	0 0	0 1	DS2	Default values set by internal DIP switches	6.6.2.1
	b	Command Entry	0	0	5	0	CMD		
EXECUTE INCREMENTAL MOVE [0051]()& [0261, 0262], (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 1	d_{10} d_{10}	d_9 d_9	DS2	*Sets move distance.* Default velocity, acceleration values set by internal DIP switches	6.6.2.2
	b		d_8	d_7	d_6	d_5	DS3		
	c		d_4	d_3	d_2	d_1	DS4		
	d	Command Entry	0	0	5	1	CMD		
EXECUTE ABSOLUTE MOVE [0052]()& [0261, 0262], (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 1	d_{10} d_{10}	d_9 d_9	DS2	Sets move position. Default values set by internal DIP switches	6.6.2.3
	b		d_8	d_7	d_6	d_5	DS3		
	c		d_4	d_3	d_2	d_1	DS4		
	d	Command Entry	0	0	5	2	CMD		
EXECUTE GO HOME [0057]()& [0284, 0285], (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 0	0 0	0 1	DS2	Seeks HOME Limit	6.6.3.1
	b	Command Entry	0	0	5	7	CMD	Default values set by internal DIP switches	
EXECUTE A PREDEFINED MOVE [0064]()& Comment (Dom, Seq)	a	Move Number	0	0	d_2	d_1	DS1	00dd from 1 to 40. Defined by [0200] through [0213]	6.6.3.2
	b	Command Entry	0	0	6	4	CMD		
EXECUTE A PREDEFINED SEQUENCE [0065]()& [0216, 0217], (Dom)	a	Sequence Number	0	0	d_2	d_1	DS1	00dd from 1 to 15	6.6.3.3
	b	Command Entry	0	0	6	5	CMD		
CONTINUE [0072] (Imm)	a	Command Entry	0	0	7	2	CMD	Command only required	6.6.4
EXECUTE CONTINUOUS MOVE USING JOG PARAMETER [0283]()& [0281, 0282] (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 0	0 0	0 1	DS2	Trapezoidal move. Default vel: 2,500 steps/sec. Accel: 2,147,483,677 steps/sec/sec	6.6.3.5
	b	Command Entry	0	2	8	3	CMD		
EXECUTE TEST MOVE [0255]() (Dom)	a	Command Entry	0	2	5	5	CMD	Test function CW move followed by CCW move. Indexer must be reset after move	6.6.3.4

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Table 6-5. Position Tracking Commands● (Continued)

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
ENABLE POSITION MAINTENANCE [0024]()& Comment (Imm, Seq)	a	Disable Enable	0 0	0 0	0 0	0 1	DS2	Enables position servo. Defined by [0176, 0177, 0179]	6.8.1
	b	Command Entry	0	0	2	4	CMD		
ENABLE MOVE TERMINATION ON STALL DETECT [0025]()& [0176, 0177], (Imm, Seq)	a	Disable Enable	0 0	0 0	0 0	0 1	DS2		6.8.2
	b	Command Entry	0	0	2	5	CMD	Execute [0176] before using this command	
SET CLOSED LOOP Offset from zero [0047]() (Imm, Seq)	a	CW Direction CCW Direction	0 0	0	0 0	d_9 d_9	DS2	Sets position counter	6.8.3
	b		d_8	d_7	d_6	d_5	DS3		
	c		d_4	d_3	d_2	d_1	DS4		
	d	Command Entry	0	0	4	7	CMD		
EXECUTE CLOSED-LOOP INCREMENTAL MOVE [0053]()& Comment (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 1	d_{10} d_{10}	d_9 d_9	DS2	Sets Encoder distance. Defined by [0177, 0261, 0262]	6.8.4
	b		d_8	d_7	d_6	d_5	DS3		
	c		d_4	d_3	d_2	d_1	DS4		
	d	Command Entry	0	0	5	3	CMD		
EXECUTE CLOSED-LOOP ABSOLUTE MOVE [0054]()& Comment (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 1	d_{10} d_{10}	d_9 d_9	DS2	Sets Encoder position. Defined by [0177, 0261, 0262]	6.8.5
	b	$d_8d_7d_6d_5$	d_8	d_7	d_6	d_5	DS3		
	c	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	d	Command Entry	0	0	5	4	CMD		
EXECUTE GO HOME CLOSED-LOOP [0058]()& [0056] (Dom, Seq)	a	CW Direction CCW Direction	0 0	0 0	0 0	0 1	DS2	Seek Channel Z HOME position	6.8.6
	b	Command Entry	0	0	5	8	CMD		
TURN ON OUTPUT ON STALL [0167]()& Comment (Imm, Seq)	a	Output 1 Output 2	0 0	0 0	0 0	1 2	DS1	[0176 to 0180]	6.8.7
	b	Disable Enable	0 0	0 0	0 0	0 1	DS2		
	c	Command Entry	0	1	6	7	CMD		
DEFINE RATIO OF MOTOR STEPS TO ENCODER STEPS [0176]() (Imm)	a	Numerator d_5	0	0	0	d_5	DS1	(Motor)	6.8.8
	b	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS2	Set to smallest ratio of whole numbers in numerator and denominator	
	c	Denominator d_5	0	0	0	d_5	DS3	Encoder	
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	1	7	6	CMD		

●Require use of an Encoder

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Table 6-6. Programming and Storage Commands

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
DEFINE AN INCREMENTAL MOVE [0200]()& [0261, 0262] (Imm)	a	Move Number	0	0	d_b	d_a	DS1	1 to 40	6.9.1.1
	b	Direction and MS Digits CW Direction CCW Direction	 0 0	 0 1	 d_{10} d_{10}	 d_9 d_9	DS2	Direction and move distance. 12 digits, 2 for direction, 10 for distance	
	c	$d_8d_7d_6d_5$	d_8	d_7	d_6	d_5	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	0	0	CMD	Value of 0 illegal	
DEFINE AN ABSOLUTE MOVE [0203]()& [0261, 0262] (Imm)	a	Move Number	0	0	d_b	d_a	DS1	d_bd_a = 1 to 40 (d = 0 to 9)	6.9.1.2
	b	Direction and MS Digits CW Direction CCW Direction	 0 0	 0 1	 d_{10} d_{10}	 d_9 d_9	DS2	Direction and move distance. 12 digits, 2 for direction, 10 for distance Maximum Distance Value: 2,147,483 647 steps $d_{10}d_9d_8d_7d_6d_5d_4d_3d_2d_1$ (d = 0 to 9)	
	c	$d_8d_7d_6d_5$	d_8	d_7	d_6	d_5	DS3		
	d	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4		
	e	Command Entry	0	2	0	3	CMD		
DEFINE A CONTINUOUS MOVE [0206]()& [0261, 0262] (Imm)	a	Move Number	0	0	d_b	d_a	DS1	Value of 0 illegal	6.9.1.3
	b	CW Direction CCW Direction	0 0	0 0	0 0	0 1	DS2		
	c	Command Entry	0	2	0	6	CMD		
DELETE A MOVE [0215]() (Imm)	a	Move Number	0		d_2	d_1	DS1	1 to 40	6.9.1.4
	b	Command Entry	0	2	1	5	CMD		
END THE SEQUENCE DEFINITION [0216] (Imm)	a	Command Entry	0	2	1	6	CMD	Indicates last command to be stored for the sequence	6.9.2.1
BEGIN THE SEQUENCE DEFINITION [0217]() (Imm)	a	Sequence Number	0	0	d_b	d_a	DS1	1 to 15	6.9.2.2
	b	Command Entry	0	2	1	7	CMD	Indicates start of sequence	
DELETE A SEQUENCE [0218] (Imm)	a	Sequence Number	0	0	d_b	d_a	DS1	1 to 15	6.9.2.3
	b	Command Entry	0	2	1	8	CMD		
SAVE PROGRAM [0291] (Dom)	a	Command Entry	0	2	9	1	CMD	Save current contents of operating memory. See text	6.9.3
RECALL PROGRAM FROM MEMORY [0292] (Dom)	a	Command Entry	0	2	9	2	CMD	Loads contents of non-volatile memory into memory. See text	6.9.4
ENABLE AUTORECALL ON POWER-UP [0293]() (Dom)	a	Disable Enable	0 0	0 0	0 0	0 1	DS2	Automatic program loading. See text	6.9.5
	b	Command Entry	0	2	9	3	CMD		

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Table 6-7. General Purpose Commands

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
NULL COMMAND [0000] (Imm)	a	Command	0	0	0	0	CMD	Can be used to replace deleted command	6.10.1
TURN ON AN OUTPUT [0011]() (Imm, Seq)	a	Output Number Out1 (Term 30) Out2 (Term 31)	 0 0	 0 0	 0 0	 1 2	DS1	Select one at a time	6.10.2.1
	b	Command Entry	0	0	1	1	CMD		
TURN OFF AN OUTPUT [0012]() (Imm, Seq)	a	Output Number Out1 (Term 30) Out2 (Term 31)	 0 0	 0 0	 0 0	 1 2	DS1	Select one at a time	6.10.2.2
	b	Command Entry	0	0	1	2	CMD		
TURN ON/OFF BOTH OUTPUTS [0013]() (Imm, Seq)	a	Both OFF Out1 ON Out2 OFF Out2 OFF Out2 ON Both ON	0 0 0 0	0 0 0 0	0 0 0 0	0 1 2 3	DS1		6.10.2.3
	b	Command Entry	0	0	1	3	CMD		
TURN ON/OFF OUTPUT ON CONDITION [0015]()& [0018] (Imm, Seq)	A	Turn OFF on Null Motor moving = ON Dominant command in process = ON Sequence in process = ON Motor accel = ON Motor decel = ON Motor velocity constant not 0 = ON Motor position within closed loop deadband = on	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 2	0 1 2 3 5 6 7 8	DS1		6.10.2.4
	b	Signal Polarity Active low Active high	 0 0	 0 0	 0 0	 0 1	DS2		
	c	Select Output Out1 Out2	 0 0	 0 0	 0 0	 0 2	DS3		
	d	Command Entry	0	0	1	5	CMD		
TURN ON REMOTE POWER SHUTDOWN [0018]()& [0219] (Seq)	a	Off On	0 0	0 0	0 0	0 1	DS2	Shuts off motor current	6.10.3.1
	b	Command Entry	0	0	1	8	CMD		
SELECT REMOTE INPUT SHUTDOWN [0019]() (Seq)	a	Enable Discrete Enable [0018]	0 0	0 0	0 0	1 0	DS2	Discrete is Terminal 32	6.10.3.2
	b	Command Entry	0	0	1	9	CMD		
SET DEFAULT POSITION PARAMETER [0280]() (Imm)	a	$d_{10}d_9$	0	0	d_{10}	d_9	DS2	10 digits (d =0 to 9)	6.10.4
	b	$d_8d_7d_6d_5$	d_8	d_7	d_6	d_5	DS3		
	c	$d_4d_3d_2d_1$	d_4	d_3	d_2	d_1	DS4	Maximum Value: See text	
	d	Command Entry	0	2	8	0	CMD		

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Table 6-7. General Purpose Commands (Continued)

Command	Entry Order	Value/Choice	BCD Digits				Strobe Used	Comment	Ref Sec.
DEFINE THE SPECIAL INPUT [0301]() (Dom)	a	Assign Register R1(DS1) R2(DS2) R3(DS3) R4(DS4) -or- Command Strobe	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	1 2 3 4 0	DS1	Entry of this command followed by entry of command to be executed when special Input (Term. 27) is grounded. See text	6.10.5
	b	Command Entry	0	3	0	1	CMD		
LIST PROGRAM [0311] (Dom)	a	Command Entry	0	3	1	1	CMD		6.10.6
TURN ON/OFF BOOST [0027]() (Lmm, Seq)	a	Turn Off Turn On	0 0	0 0	0 0	0 1	DS2		6.10.7
	b	Command Entry	0	0	2	7	CMD		
TURN ON/OFF AUTOMATIC BOOST [0029]() (Lmm, Seq)	a	Turn Off Turn On	0 0	0 0	0 0	0 1	DS2		6.10.8
	b	Command	0	0	2	9	CMD		
TURN ON/OFF DRIVE RESET [0026]() (Lmm)	a	Turn Off Turn On	0 0	0 0	0 0	0 1	DS2		6.10.9
	b	Command	0	0	2	6	CMD		
TURN ON/OFF GEARSHIFT [0028]() (Lmm)	a	Turn Off Turn On	0 0	0 0	0 0	0 1	DS2		6.10.10
	b	Command	0	0	2	8	CMD		

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6.3 DETAILED DESCRIPTION OF 430 BCD COMMANDS

Each function group corresponding to one of the summary program command tables of section 6.2 is described in a separate section.

A standard format (Figure 6-3) is used for the detailed description of the commands. Example 1 of Figure 6-3 illustrates a command that requires additional command data. The number of data words required, which corresponds to the number of data registers used, is listed immediately below the command description line. (Entry can require one to four data words). In Example 2, four data words are required.

The specific data required is described immediately below the second line (**Number of Data Words:**). The content of each data register used is defined plus the limits on data values specified.

In Example 1, the allowed values for the register are 0 or 1. This requirement is highlighted in the command description line by the data word notation (000b). If the data word digit were a decimal number between 0 and 9, a "d" instead of a "b" would be used, as shown in Example 2. When the data word represents a set of values, the set of values is presented immediately below the subject data word. (See Figure 6-3, Example 2.)

The last portion of the detailed command description text is a definition of the functions performed by the command.

6.4 SHAFT MOTION PARAMETER COMMANDS

The shaft motion parameters include direction, velocity, and acceleration. These commands, which set up the way the Compumotor motor shaft will move, are summarized in Table 6-1.

If the velocity or acceleration values entered exceed the capability of the motor/drive, the motor/drive will stall without damage when a move using these values is executed.

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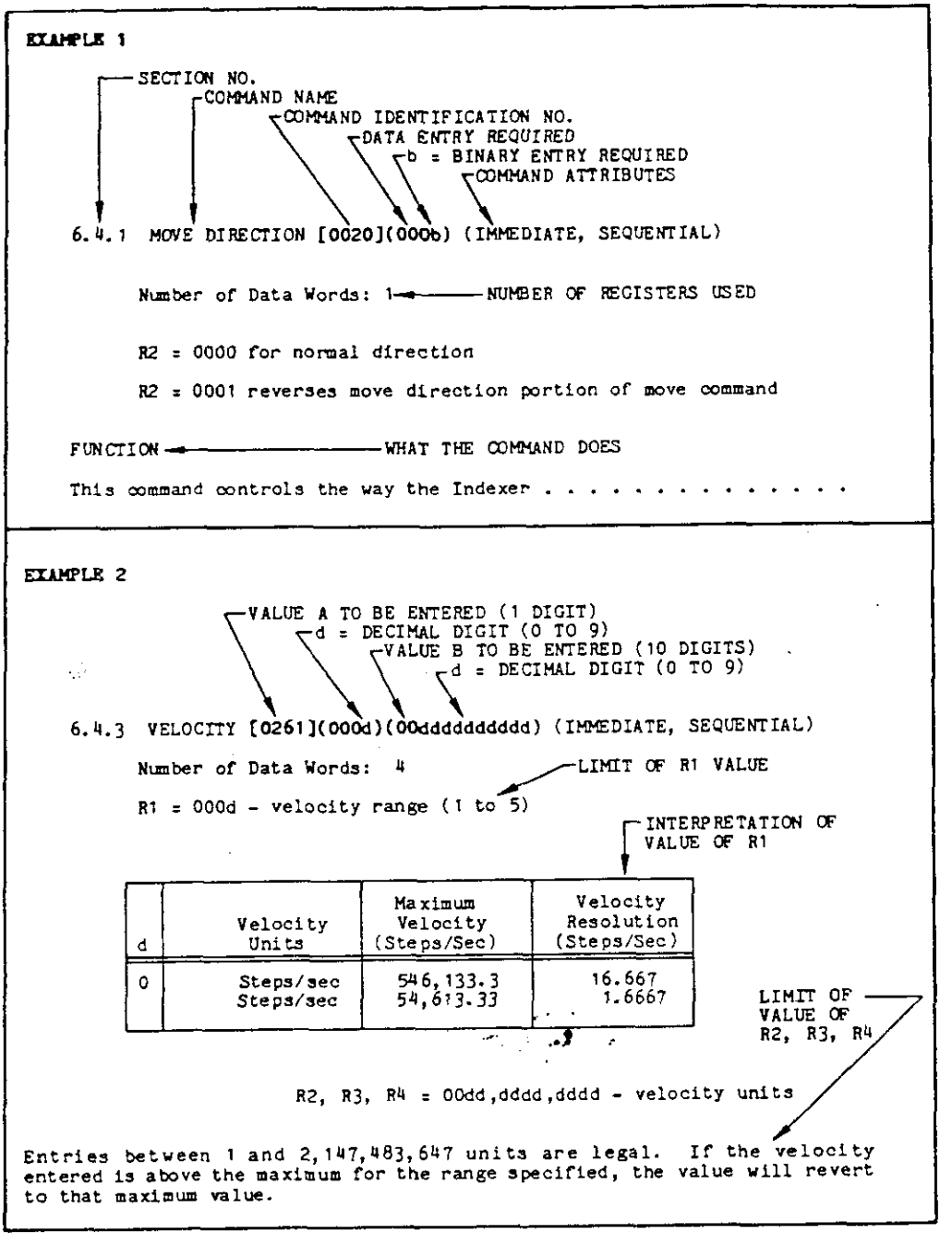


Figure 6-3. Command Description Formats

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6.4.1 SET MOVE DIRECTION **[0020](000b)**(IMMEDIATE,SEQUENTIAL, SAVED)

Number of Data Words: 1

R2 = 0000 for normal direction
R2 = 0001 reverses move direction portion of move command

FUNCTION

This command controls the way the Indexer interprets the direction information included in all move commands. When R2 = 0000, the direction of motion of all moves is in accordance with that of a specific command or the status of Terminal 36 (**DIRECTION**). R2 = 0001 reverses the interpretation of the direction information so that predefined incremental moves will run backwards, and absolute positioning operations will be executed in mirror-image fashion on the opposite side of the zero position. R2 = 0001 reverses the sense of the front panel **DIRECTION** input. In addition, R2 = 0001 will cause any *GO HOME operation to be executed in the reverse direction*, with the exception that the final approach direction will not be reversed, and the final stopping position will be on the same side of the HOME limit signal as originally defined. **Caution is recommended when using this command.** After power-on or **RESET**, the Indexer defaults to normal direction interpretation (equivalent of R2 = 0000).

6.4.2 SET START/STOP VELOCITY **[0214](00dddddddddd)** (IMMEDIATE, SEQUENTIAL, SAVED)

Number of Data Words: 3

R2,R3,R4 = 00dd,dddd,dddd - the Start/Stop velocity in steps/sec
(1 to 2,147,483,647 steps/second)

FUNCTION

This command defines the Start/Stop velocity. The Start/Stop velocity feature is used with low resolution stepper motors to skip over low velocities where these motors will exhibit catastrophic resonance effects. When executing a move whose velocity is greater than the Start/Stop velocity, the acceleration to that velocity begins at the Start/Stop

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velocity, and deceleration ends at the Start/Stop velocity. Acceleration to and deceleration from the Start/Stop velocity is instantaneous. When executing a move whose velocity is less than the Start/Stop velocity, acceleration to that velocity will be instantaneous. The Start/Stop velocity is always specified in units of steps per second. After power-on or **RESET**, the Start/Stop velocity is defined as zero.

The Start/Stop velocity is a part of all moves performed except for the final approach portion of the GO HOME operation.

6.4.3 SET VELOCITY **[0261](000d)(00ddddddddddd)** (IMMEDIATE, SEQUENTIAL, SAVED)

Number of Data Words: 4

R1 = 000d - velocity range (0 to 5)

R1 (d)	Velocity Units	Maximum Velocity (Steps/Sec)	Velocity Resolution (Steps/Sec)	Step Pulse Width (Microseconds)
0	Steps/sec	546,133.3	16.667	1
1	Steps/10 sec	54,613.33	1.6667	10
2	Steps/100 sec	5,461.333	0.16667	100
3	Steps/1000 sec	546.1333	0.016667	1000
4	Steps/min	9,102.222	0.27778	60
5	Steps/1/2 sec	1,092,266.67	33.333	2

R2,R3,R4 = 00dd,dddd,dddd - velocity units

If an invalid velocity range is specified, the command is ignored. Range zero is typically used with a Compumotor motor/drive. If the velocity entered is above the maximum for the range specified, the value will revert to that maximum value.

FUNCTION

This command defines a default velocity to be used for all moves except PERFORM A CONTINUOUS MOVE USING THE JOG PARAMETERS (Command **[0283]**).

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The velocity defined by this command will only apply to moves defined after this command is invoked. Moves defined before this command is issued will use the velocity and acceleration defined at the time they were defined. If this command is not used, a default value for the velocity (and acceleration) is established by the internal DIP switches when power is applied to the 430. See section 3.7 for details regarding the location and setting of the DIP Switches.

---------- START EXAMPLE ----------

Suppose you have a 1,000 step per revolution drive, with a top speed of 1800 RPM (30 rev/sec), which requires a 5-microsec step-pulse width. In order to generate a move at a velocity of 900 RPM (15 rev/sec), you must enter this command with the following considerations:

a. Step pulse width must be 5 microsec or more...select Range 1

b. Velocity must be converted to the right units:

900 RPM requires 15,000 steps/sec
15,000 steps/sec must be entered as 150,000 steps/10 seconds for Range 1

The resulting command and data word structure is

(Range) (Velocity Value)

R1	R2	+ R3	+ R4	Cmd
0001	0000	0015	0000	0261

---------- END EXAMPLE ----------

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6.4.4 SET ACCELERATION **[0262] (000d) (00ddddddddddd)**(IMMEDIATE, SEQUENTIAL, SAVED)

Number of Data Words: 4

R1 = 000d - acceleration range (0 to 2)

d = 0 accel units are velocity units per second
d = 1 accel units are velocity units per 10 seconds
d = 2 accel units are velocity units per 100 seconds

If an invalid range is specified, the command is ignored.

R2,R3,R4= 00dd,dddd,dddd - acceleration value
(1 to 2,147,483,647 acceleration units)

FUNCTION

This command defines the default acceleration to be used for all moves except PERFORM A CONTINUOUS MOVE USING THE JOG PARAMETERS (Command **[0283]**) and the ***JOG +*** and ***JOG -*** inputs. The acceleration defined by this command will only apply to moves defined after this command is invoked. Moves defined before this command is issued will use the velocity and acceleration defined at the time they were defined.

If this command is not used, a default value for the acceleration (and velocity) is established by the internal DIP switches when power is first applied to the 430. See section 3.7 for details regarding the location and setting of DIP switches.

6.4.5 SET JOG VELOCITY **[0281](000d)(00ddddddddddd)** (IMMEDIATE, SEQUENTIAL, SAVED)

Number of Data Words: 4

R1 = 000d - velocity range (0 to 5)

Note

See section 6.4.3 for specific values of R1.

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If an invalid velocity range is specified, the command is ignored.

R2,R3,R4 = 00dd,dddd,dddd (velocity units)

Entries between 1 and 2,147,483,647 units are legal. If the velocity entered is above the maximum for the range specified, the value will revert to the maximum value for the range.

FUNCTION

This command defines the JOG velocity, which is used only for PERFORM A CONTINUOUS MOVE USING THE JOG PARAMETERS (Command **[0283]**) with the **JOG +** and ***JOG -*** inputs.

The velocity defined by this command will only apply to JOG moves. The initial value for the JOG velocity is defined at power-on to be 2,500 steps per second (slow).

6.4.6 SET JOG ACCELERATION **[0282](000d)(00ddddddddd)** (IMMEDIATE, SEQUENTIAL)

Number of Data words: 4

R1 = 000d - acceleration range (0 to 2)

d = 0 accel units are velocity units per second
d = 1 accel units are velocity units per 10 seconds
d = 2 accel units are velocity units per 100 seconds

If an invalid range is specified, the command is ignored.

R2,R3,R4 = 00dd,dddd,dddd - acceleration value
(1 to 2,147,483,647 acceleration units)

FUNCTION

This command defines the JOG acceleration, which is used only for PERFORM A CONTINUOUS MOVE USING THE JOG PARAMETERS (Command **[0283]**) with the **JOG +** and **JOG -** inputs.

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The acceleration defined by this command will only apply to JOG moves. The initial value for the JOG acceleration is 2,147,483,647 steps per second per second (maximum).

6.4.7 SET GO HOME VELOCITY [0284](000d)(00ddddddddd) (IMMEDIATE, SEQUENTIAL)

Number of Data Words: 4

R1 = 000d - velocity range (0 to 5)

Note

See section 6.4.3 for specific values of R1.

If an invalid range is specified, the command is ignored.

R2,R3,R4 = 00dd,dddd,dddd - (velocity units)

Entries between 1 and 2,147,483,647 units are legal. If the velocity entered is above the maximum for the range specified, the value will revert to the maximum value for the range.

FUNCTION

This command defines the GO HOME velocity, which is used by the GO HOME and GO TO CLOSED-LOOP HOME commands (Commands **[0057]** and **[0058]**) and the **GO HOME** input. The velocity defined by this command will only apply to GO HOME moves. The initial value for the GO HOME velocity is defined by DIP switches (SW1-1 to -5). See section 3.7 for details on the location and setting of DIP switches.

6.4.8 SET GO HOME ACCELERATION [0285](000d)(00ddddddddd) (IMMEDIATE, SEQUENTIAL)

Number of Data words: 4

R1 = 000d - acceleration range (0 to 2)

d = 0 accel units are velocity units per second
d = 1 accel units are velocity units per 10 seconds
d = 2 accel units are velocity units per 100 seconds

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If an invalid range is specified, the command is ignored.

R2,R3,R4 = 00dd,dddd,dddd - acceleration value
(1 to 2,147,483,647 acceleration units)

FUNCTION

This command defines the GO HOME acceleration, which is used by the GO HOME and GO TO CLOSED-LOOP HOME commands (Commands **[0057]** and **[0058]**) and the **GO HOME** input.

The acceleration defined by this command applies to GO HOME moves only. DIP switches SW3-6 to -8 and SW4-1 to -8 define the initial value for the GO HOME acceleration. See section 3.7 for details.

6.5 POSITION DEFINITION COMMANDS

Described in detail below, these commands are summarized in Table 6-2.

6.5.1 SET OFFSET FROM ZERO **[0046](0b0ddddddddd)** (IMMEDIATE, SEQUENTIAL)

Number of Data Words: 3

R2,R3,R4 = 000d,dddd,dddd - Number of clockwise steps from zero
= 010d,dddd,dddd - Number of counterclockwise steps from zero
(1 to 134,217,728 steps)

Values of the first two digits of R2 other than 00 or 01 here will cause this command to be ignored. If an absolute position is specified that is outside the legal range, this command is ignored.

FUNCTION

This command defines the present position as an offset (in motor steps) from zero (equivalent to the post-move position after an ABSOLUTE move). The two highest order digits entered in R2 define the direction of the offset. To set the current position to zero, use Command **[0048]**.

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6.5.2 SET THE PRESENT POSITION AS ABSOLUTE ZERO **[0048]**(IMMEDIATE, SEQUENTIAL)

Number of Data Words: none

FUNCTION

This command causes the current position of the motor to be assigned as the absolute zero position. The absolute zero position is the reference point for absolute positioning moves. After power-on or **RESET**, absolute zero is defined to be the position the motor is at when the power-on or **RESET** occurred. The Indexer will set its internal position counter to zero for both open- and closed-loop operation.

Note

The absolute zero position and the position of the HOME limit switch are two independent locations and only coincide if first a GO HOME command (Command **[0057]**) is executed then the **[0048]** command is executed.

6.5.3 DEFINE HOME **[0056](0ddd)(0bbb)** (IMMEDIATE, SEQUENTIAL, SAVED)

Number of Data Words: 2

R1 = 0ddd, Edge Approach Velocity defined as a percentage of GO HOME velocity (1 to 100%) (use SW1-1 thru -4)

R2 = 0 b_3 b_2 b_1

- always 0
- active state of HOME input, 0 = low and 1 = high
- active edge of HOME input, 0 = CW edge and 1 = CCW edge*
- final approach direction, 0 = CW and 1 = CCW

*Ignored for closed-loop GO HOME

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FUNCTION

This command allows the user to define the precise HOME position with respect to a **HOME** input signal of finite width and fixed position, regardless of the initial approach direction. This signal is typically supplied by a load-activated switch when the load is in the desired position. The command also defines the velocity and direction used to make the final approach. If this command is not invoked, default values for the above conditions are obtained from the internal DIP switch settings at power-on.

Edge Approach Velocity — The Edge Approach Velocity, specified by R1, is the velocity at which the final search for the HOME position is conducted. No acceleration parameter is used in this final phase of the homing operation. Therefore, the motor must be able to reach the designated speed from a standstill. Consequently, a heavy load requires a low speed. The repeatability of the HOME position is related to the Edge Approach Velocity. A lower Edge Approach Velocity yields a more repeatable and more accurate final HOME position. The Edge Approach Velocity is determined as a percentage of the last velocity parameter used. Velocity may be defined with Command **[0261]**. Percentages greater than 100 or equal to 0 are invalid and will cause its command to be ignored. To determine the actual Edge Approach Velocity, use the following formula:

Edge Approach Velocity = (default velocity*) X R1/100

Active State of HOME Input -- b_3 of data word R2 defines the active state of the **HOME** input. b_3 = 0 means the **HOME** input is active low. b_3 = 1 means the **HOME** input is active high. The HOME input is a level-sensitive input and must be active for a minimum of four milliseconds during the homing operation in order for the Indexer to perform properly (see Figure 6-4).

Active Edge of HOME Input — b_2 of data word R2 defines the edge that will be used for GO HOME.

*Set with command [0261]

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When searching for the HOME position, the 430 searches for a specific edge of the active **HOME** input.

The clockwise and counterclockwise edges of an active high **HOME** input are shown in Figure 6-5. The edge defined as HOME is independent of the direction definition (see Command **[0020]**), as is the Final Approach Direction discussed below. This is to insure that the homing operation will always finish in the same location.

If b_2 = 0, the HOME position is the clockwise (CW) edge of the active **HOME** input, if b_2 = 1 the HOME position is the counterclockwise (CCW) edge of the active **HOME** input. For example, as the motor moves the load past the HOME limit switch, the initial switch closure marks the "leading edge" of the signal as shown above. The switch opens again when the load has gone by, giving the "trailing edge" of the signal. If the motor is turning in the clockwise direction, the trailing edge is defined as the clockwise edge.

If the Indexer is performing a closed-loop GO HOME, the edge definition given by b_2 is ignored. Instead, the homing edge is defined by the Final Approach Direction and an internal DIP switch (see section 3.7).

Final Approach Direction -- b_1 of data word R2 specifies the Final Approach Direction for finding the HOME position. This means that the HOME position will always be approached from the same absolute direction. If b_1 = 0, the final approach will be in the clockwise direction. If b_1 = 1, the final approach is in the counterclockwise direction.

The GO HOME move is designed to be rapid and repeatable. The initial search direction is specified with the GO HOME command (Command **[0057]**). If an end-of-travel limit is encountered, the motor will reverse and search in the other direction. If the limit switch at the opposite end-of-travel is pressed, the search for HOME is abandoned.

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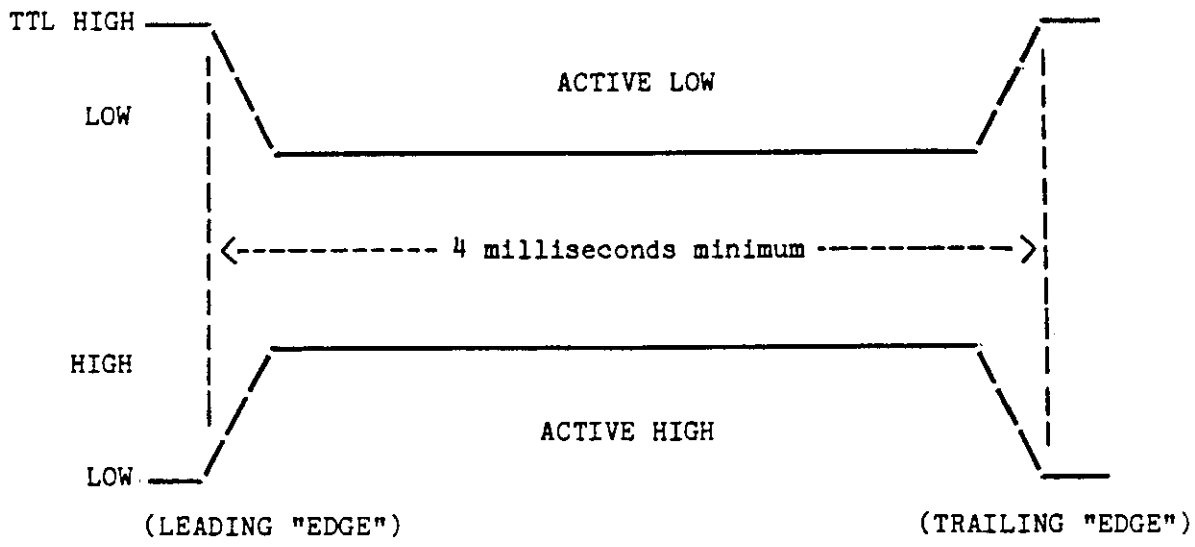


Figure 6-4. Active Low and Active High HOME Inputs

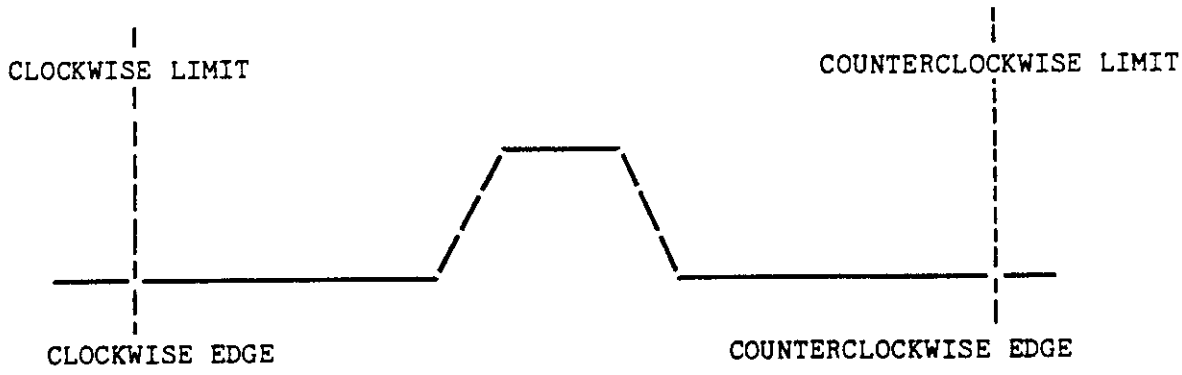


Figure 6-5. Active High Signal Edges

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Figure 6-6 shows the Homing cycle starting initial search for the **HOME** input (1). When the active edge of interest is found (2) (either at constant velocity or during acceleration), the Indexer will begin to decelerate the motor.

This results in overshoot due to deceleration (3). The Indexer notes the distance it has overshot and will perform a recovery move (4) to get back to the approximate location of the HOME position. The final approach (5) to the HOME position will be performed at the specified percent of default velocity (defined in R1) in the specified absolute direction (defined in R2).

6.6 EXECUTE or CONTINUE COMMANDS

These commands are summarized in Table 6-3. This group includes commands to:

a. Repeat a sequence of commands (**[0032] [0033]**)

b. Define and execute a move (**[0050], [0051], [0052]**)

c. Execute a predefined move (**[0057], [0064], [0065], [0255], [0283]**)

d. Continue a suspended operation **[0072]**

6.6.1 REPEAT COMMANDS

6.6.1.1 LOOP **[0032](0ddd)(000ddddd)** (SEQUENTIAL)

Number of Data Words: 3

R1 = 0ddd - number of commands to be repeated (1 to 255)
R2,R3 = 000d,dddd - number of times to repeat (1 to 65,535)

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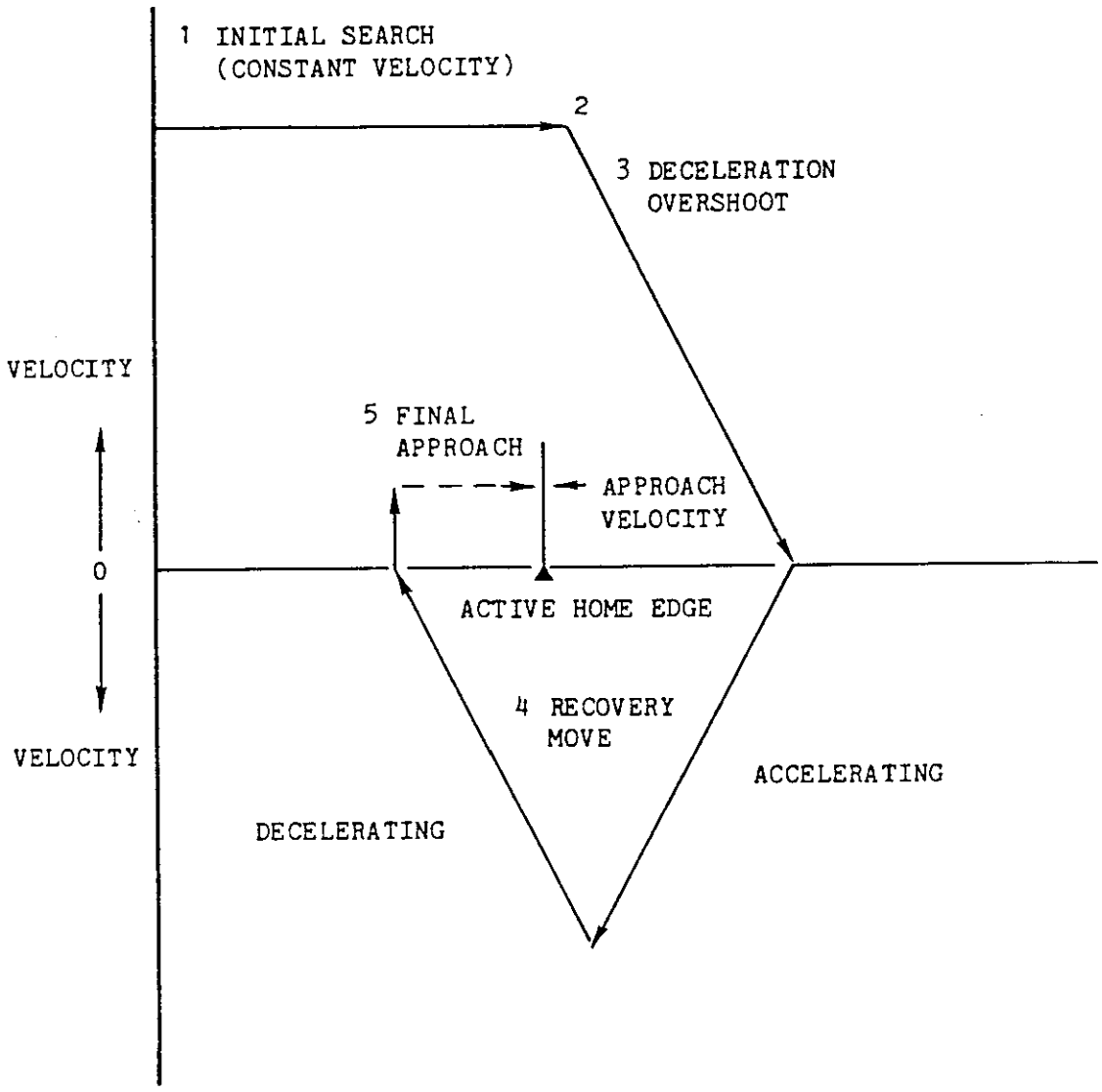


Figure 6-6. Homing Cycle

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FUNCTION

This command can be used only in a PREDEFINED SEQUENCE. Its purpose is to allow repetitive execution of a list of commands. A maximum of 255 commands may be within the loop. The loop may be repeated up to 65,535 times. A LOOP command inserted within another LOOP command will be ignored. If zero is specified in R1 or in R2 and R3, the command is ignored. To perform an "infinite" loop, use [0033] below and don't enter the CONTINUE [0072] command.

Note

LOOP commands are processed in such a way that an exclusive operation dominant command must follow the LOOP command in the sequence. If there are no moves included in the sequence that follows the LOOP command, add a short time delay (1 msec) outside the loop to the sequence using Command **[0041]** (section 6.7.1.2).

6.6.1.2 EXECUTE LOOP UNTIL CONTINUE **[0033](0ddd)** (SEQUENTIAL)

Number of Data Words: 1

R1 = 0ddd - number of commands to be repeated (1 to 255)

FUNCTION

This command can be used only in a PREDEFINED SEQUENCE. Its purpose is to allow repetitive execution of a list of commands until the external controller issues a CONTINUE command (Command **[0072]**). Upon receipt of a CONTINUE command, the loop command list will be completed, and any commands following the loop in the PREDEFINED SEQUENCE will then be executed. A LOOP command inserted within another LOOP command will be ignored. Never entering the CONTINUE command constitutes and "infinite loop".

6.6.2 SINGLE MOVE DEFINITION AND EXECUTION COMMANDS

6.6.2.1 EXECUTE CONTINUOUS MOVE **[0050](000b)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 - clockwise,
= 0001 - counterclockwise

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FUNCTION

This command will accelerate the motor to run at constant speed using the velocity and acceleration defined in Commands **[0261]** and **[0262]** as parameters. The value in R2 specifies the direction in which the move is to be executed. These directions may be reversed using the DEFINE MOTOR DIRECTION command (Command **[0020]**). If the velocity and acceleration have not been defined since power-on, the default values for these parameters set on the internal DIP switches will be used.

6.6.2.2 EXECUTE PERFORM AN INCREMENTAL MOVE **[0051](0bddddddddddd)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 3

R2,R3,R4 = 00dd,dddd,dddd - clockwise move
= 01dd,dddd,dddd - counterclockwise move
(1 to 2,147,483,647 steps)

FUNCTION

This command executes a move of a number of steps at the velocity and acceleration defined by Commands **[0261]** and **[0262]**. The direction of the move is defined by the first two digits of the value entered in R2. Values other than 00 or 01 here will cause this command to be ignored. If the velocity and acceleration have not been defined since power-on, their values will be the default values set on the internal DIP switches.

This command cannot be executed with Position Maintenance on.

6.6.2.3 EXECUTE PERFORM AN ABSOLUTE MOVE **[0052](0b0ddddddddd)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 3

R2,R3,R4 = 000d,dddd,dddd - clockwise move
= 010d,dddd,dddd - counterclockwise move
(1 to 134,217,728 steps)

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FUNCTION

This command executes a move to an absolute position a number of steps away from the absolute zero position at the velocity and acceleration defined by Commands **[0261]** and **[0262]**. The direction of the move is given by the first two digits of the value in register R2. Values other than 00 or 01 here will cause this command to be ignored. If an absolute position is specified that is outside the legal range, or if the current absolute position of the motor is outside the legal range, no move will be executed. If the motor is positioned outside the valid absolute positioning range (-134,217,728 through +134,217,728), a relative move must be executed to reposition the motor within the valid absolute positioning range before any absolute moves may be executed. Executes only with Position Maintenance off.

6.6.3 EXECUTE PREDEFINED MOVE COMMANDS (Cannot be executed with Position Maintenance on)

6.6.3.1 EXECUTE GO HOME **[0057](000b)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 initial search direction - clockwise
= 0001 initial search direction - counterclockwise

FUNCTION

This command will cause the Indexer to move the motor in search of the HOME limit switch at the velocity and acceleration defined by Commands **[0284]** and **[0285]** or by the internal DIP switches at power-on. If an end-of-travel limit is encountered, the motor will reverse and try searching in the other direction. If the limit switch at the opposite end of travel is pressed, the search for HOME is abandoned. The HOME approach velocity takes the place of the normal Start/Stop velocity in this move.

The value in R2 specifies the direction the Indexer will begin moving the motor as it begins its search for the **HOME** input. This command will not be performed if issued when the motor is moving. If the **HOME** input and final approach parameters have not been defined since power-on, the values on the internal DIP switches will be used.

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6.6.3.2 EXECUTE A PREDEFINED MOVE **[0064](00dd)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 1

R1 = 00dd, Predefined Move number (1 to 40)

FUNCTION

This command will cause the Indexer to perform a previously defined move referenced by the number in R1. The move definition contains information specifying the direction, velocity, acceleration, distance, and move type (incremental, absolute, or continuous). Moves are predefined using Commands **[0200]** through **[0213]**. A command to execute a move whose number is outside the above range or a move that has not been defined will be ignored. The motor must be stopped for this command to be executed.

6.6.3.3 EXECUTE A PREDEFINED SEQUENCE **[0065](00ddd)&** (DOMINANT)

Number of Data Words: 1

R1 = 00dd - PREDEFINED SEQUENCE number (1 to 15)

FUNCTION

This command causes a previously defined sequence to be executed. A sequence may be defined using Commands **[0216]** and **[0217]**. Up to 15 different sequences may be defined. If the sequence has not been defined, this command is ignored. The function of this command may be duplicated using the **SPECIAL** input (see Command **[0301]**).

6.6.3.4 EXECUTE TEST MOVE **[0255]** (DOMINANT)

Number of Data Words: None

FUNCTION

This command causes a set pattern of motion. If a standard Compumotor motor/drive (25,000 steps per revolution) is connected to the 430, the

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motor shaft will turn one complete revolution in the counterclockwise direction and then one complete revolution in the clockwise direction. The signal to the motor/drive during each of the above moves is 5000 steps per second which results in a 0.2 revolution-per-second move. Following the move, the **Status** indicator on the front of the 430 will light (red), and the **ERROR** output will be active. To restore the Indexer to normal operation after this command is used, RESET the Indexer by cycling AC power or by driving the **RESET** input low.

6.6.3.5 EXECUTE CONTINUOUS MOVE USING THE JOG PARAMETERS [0283](000b)& (DOMINANT, SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 - clockwise move
= 0001 - counterclockwise move

FUNCTION

This command will perform a trapezoidal continuous move using the JOG velocity and JOG acceleration defined in Commands [0281] and [0282] as parameters. If the JOG velocity and acceleration have not been defined since power-on, default parameters will be defined as follows:

JOG velocity: 2,500 steps/second
JOG acceleration: 2,147,483,647 steps/second squared

6.6.4 CONTINUE COMMANDS

6.6.4.1 CONTINUE [0072] (IMMEDIATE)

Number of Data Words: None

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If a command has been performed instructing the Indexer to wait for a CONTINUE command, this command allows processing to proceed. Otherwise this command is ignored.

6.7 STOP or PAUSE COMMANDS

The STOP or PAUSE commands are summarized in Table 6-4 and described in the sections below. These commands can be grouped as follows:

a. STOP and WAIT commands (6.7.1.)
   - Wait for CONTINUE ([0040], 6.7.1.1)
   - Wait N Milliseconds ([0041], 6.7.1.2)
   - Wait N Seconds ([0042], 6.7.1.3,)
   - Wait N Minutes ([0043], 6.7.1.4)
   - Wait for a Trigger ([0044], 6.7.1.5)
   - Suspend Sequence, Wait for Continue ([0114], 6.7.1.6)
   - Suspend Sequence on Trigger 1, Wait for Continue ([0118], 6.7.1.7)

b. STOP Motion Commands (6.7.2)
   - Stop Motion ([0112], 6.7.2.1)
   - Discontinue Sequence ([0113], 6.7.2.2)
   - Discontinue Any Predefined Single Move in Progress ([0115], 6.7.3.2)
   - Stop Motion on Trigger 1 ([0116], (6.7.2.4)
   - Discontinue Sequence on Trigger 1 ([0117], (6.7.2.5)
   - Discontinue Any Predefined Move Command on Trigger 1 ([0119], 6.7.2.6)
   - Kill Motion ([0120], (6.7.2.7)
   - Kill the Sequence ([0121], (6.7.2.8)
   - Kill Motion on Trigger 1 ([0123], (6.7.2.9)
   - Kill the Sequence on Trigger 1 ([0125], (6.7.2.10)

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6.7.1 STOP AND WAIT COMMANDS

This set of commands suspends command execution until either an external input is sent to the Indexer or a period of time has elapsed.

6.7.1.1 WAIT FOR CONTINUE **[0040]** (DELAYED ACTION, SEQUENTIAL)

Number of Data Words: None

FUNCTION

This command cause the Indexer to suspend processing of a sequence until an external CONTINUE command (Command **[0072]**) is issued. Other immediate commands may be issued and executed before the CONTINUE command is entered. Execution of the halted Sequence will not proceed until a CONTINUE command is issued.

6.7.1.2 WAIT N MILLISECONDS **[0041](00ddddddddddd)** (SEQUENTIAL)

Number of Data Words: 3

R2, R3, R4 = 00dd,dddd,dddd - the number of milliseconds (1 to 4,294,967,295) (approximately 50 days).

FUNCTION

This command causes the Indexer to delay the specified number of milliseconds before executing the next command in the PREDEFINED SEQUENCE. A time delay of zero is invalid and will be ignored.

6.7.1.3 WAIT N SECONDS **[0042](00ddddddd)** (SEQUENTIAL)

Number of Data Words: 2

R2,R3 = 000d,dddd - number of seconds (1 to 65,535) (approximately 18 hours)

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FUNCTION

This command causes the Indexer to delay the specified number of seconds before executing the next command in the PREDEFINED SEQUENCE. A time delay of zero is invalid and will be ignored.

6.7.1.4 WAIT N MINUTES **[0043](000ddddd)** (SEQUENTIAL)

Number of Data Words: 2

R2,R3 = 000d,dddd - number of minutes (1 to 65,535) (approximately 45 days)

FUNCTION

This command causes the Indexer to delay the specified number of minutes before executing the next command in the PREDEFINED SEQUENCE. A time delay of zero is invalid and will be ignored.

6.7.1.5 WAIT FOR A TRIGGER **[0044](000d)(000b)** (DELAYED ACTION, SEQUENTIAL)

Number of Data Words: 2

R1 = 000d - number of the **TRIGGER** input (1 to 3)
R2 = 0000 - active state of the **TRIGGER** = low,
= 0001 - active state high
(**TRIGGER** 1 is always active low)

FUNCTION

This command is very similar in function to the WAIT FOR A CONTINUE command (Command **[0040]**). When this command is encountered in the command sequence, execution of the PREDEFINED SEQUENCE will stop until the specified **TRIGGER** input activates. If the **TRIGGER** input number designated in R1 is other than 1, 2, or 3, the command will be ignored.

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There are two types of **TRIGGER** inputs (see Figure 6-7). **TRIGGER 1** is a faster acting input, but may be activated only by switching it from high to low. **TRIGGERs 2** and **3** are slower, but may be programmed to be active in either the high or low state. **TRIGGER 1** must be asserted for 200 microseconds to be recognized and must be sent high again for 2 milliseconds before retriggering. **TRIGGERs 2** and **3** must be held constant at the designated high or low level for at least 4 milliseconds.

6.7.1.6 *SUSPEND THE SEQUENCE; WAIT FOR CONTINUE* **[0114]** *(DELAYED ACTION,* IMMEDIATE)

Number of Data Words: None

FUNCTION

When this command is included in a PREDEFINED SEQUENCE, or issued during sequence execution, sequence execution is suspended until a CONTINUE command (Command **[0072]**) is received. The Indexer completes execution of its current command and then waits. Upon receipt of a CONTINUE command, the Indexer resumes execution of the PREDEFINED SEQUENCE starting with the command following this one. If a PREDEFINED SEQUENCE is not being performed when this command is executed, this command is ignored.

Note

If this command is issued in the middle of a continuous move, the motor will continue to run at its current speed until CONTINUE is entered, at which time it will decelerate to a stop and proceed with the Sequence. PRESET moves will be completed before execution halts.

6.7.1.7 SUSPEND THE SEQUENCE ON TRIGGER 1; WAIT FOR CONTINUE **[0118](000b)** (DELAYED ACTION, IMMEDIATE, SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 function disabled
= 0001 function enabled

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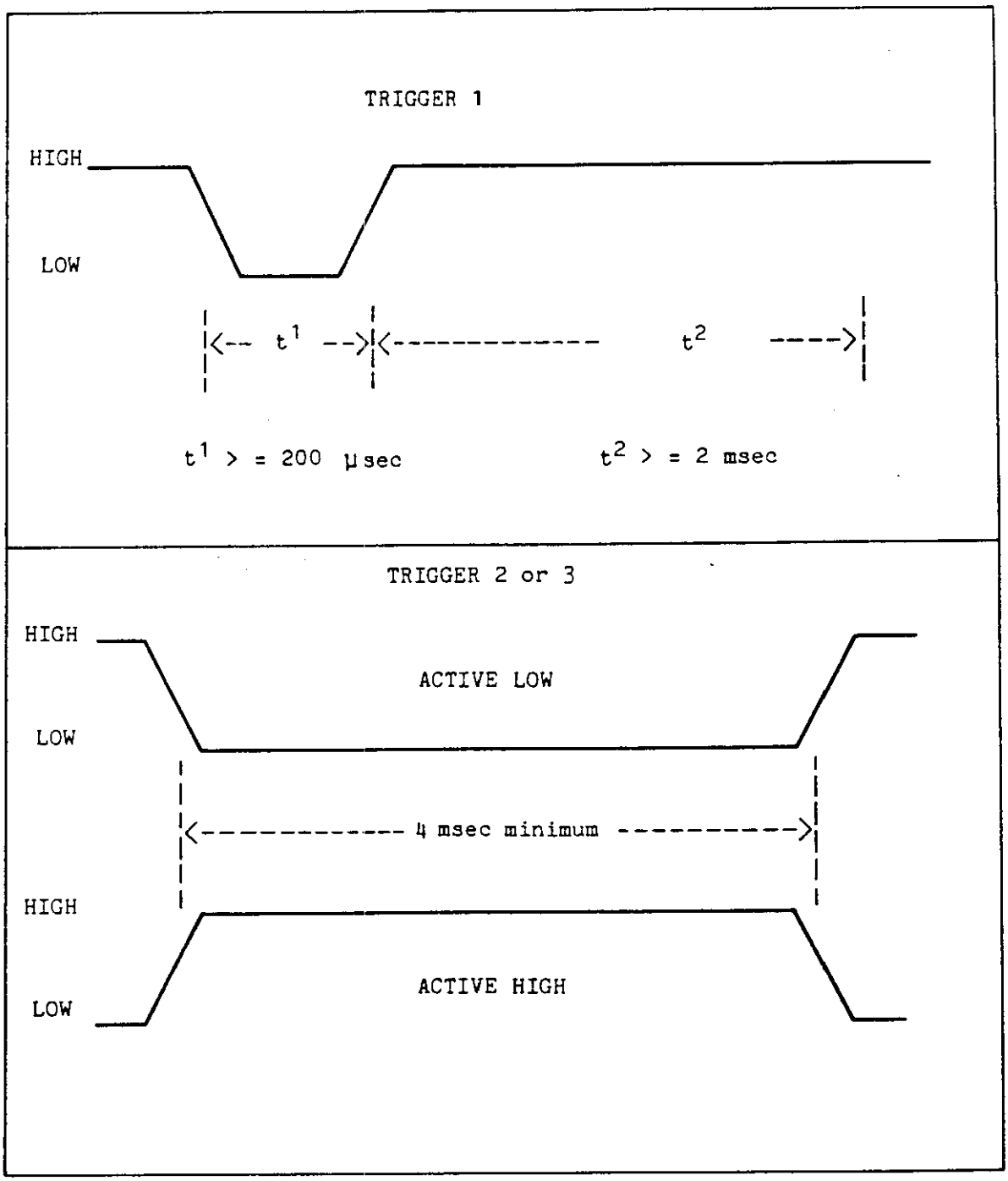


Figure 6-7. Trigger Signal Inputs

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FUNCTION

When the SUSPEND function is turned ON, this command is very similar to Command **[0114]**. Rather than suspending the PREDEFINED SEQUENCE when this command is received, the sequence will be suspended when TRIGGER 1 activates. Upon receipt of a CONTINUE command, execution of the sequence will proceed with the next command. If a PREDEFINED SEQUENCE is not being performed when the specified TRIGGER activates, the TRIGGER is ignored. Following power-on or **RESET**, function is disabled.

Only one function may be performed by a given **TRIGGER** input at a given time. For example, if **TRIGGER 1** has already been initialized to STOP motion, no other function may be specified for **TRIGGER 1** until the STOP motion function is disabled.

This command is used to stop execution of a PREDEFINED SEQUENCE until a subsequent **CONTINUE** command is issued. If the PREDEFINED SEQUENCE in which this command is used also instructs the 430 to define the **SPECIAL** input to serve as the **CONTINUE** command, then **TRIGGER 1** will stop execution, and **SPECIAL** will restart execution of this PREDEFINED SEQUENCE.

6.7.2 STOP MOTION COMMANDS

6.7.2.1 STOP MOTION [0112] (IMMEDIATE)

Number of Data Words: None

FUNCTION

This command performs a controlled deceleration of any motor motion due to execution of a move command. The deceleration rate is equal to the acceleration rate of the most recently executed move.

Note

If the Indexer is executing a PREDEFINED SEQUENCE, the next step in the sequence will be executed.

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6.7.2.2 STOP MOTION ON TRIGGER 1 **[0116](000b)** (DELAYED ACTION, IMMEDIATE, SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 function disabled
= 0001 function enabled

FUNCTION

The effect of this command is similar to the STOP MOTION command (Command **[0112]**). A controlled deceleration of any motion due to the performance of a move occurs when TRIGGER 1 activates. If not, execution of commands continues. The deceleration rate used is the acceleration rate defined for the most recently performed move. Following power-on or **RESET**, this function is disabled.

Note

If the Indexer is executing a **PREDEFINED SEQUENCE**, the next step in the sequence will be executed.

Only one function may be assigned to a given **TRIGGER** input at a given time. For example, if **TRIGGER 1** has already been initialized to STOP motion on active **TRIGGER 1**, no other function may be specified for active **TRIGGER 1** until the STOP MOTION function is disabled.

6.7.2.3 KILL MOTION **[0120]** (IMMEDIATE)

Number of Data Words: None

FUNCTION

Any motor motion that is occurring at the time this command is issued is immediately stopped. The action of this command is equivalent to hitting a limit switch. Motor step pulses are stopped immediately; there is no deceleration to zero velocity.

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Note

Any sequence that is in progress will continue; therefore, this command should be used: Command [0272] to stop everything.

6.7.2.4 KILL MOTION ON TRIGGER 1 **[0124](000b)** (DELAYED ACTION, IMMEDIATE, SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 function disabled
= 0001 function enabled

FUNCTION

The effects of this command are similar to the KILL MOTION command (Command **[0120]**). Any motion that is occurring at the time TRIGGER 1 activates is immediately stopped. Pulses are stopped immediately; there is no deceleration to zero velocity. The action of the TRIGGER is equivalent to hitting a limit switch. If no TRIGGER is received, execution of commands continues. Following power-on or **RESET**, this function is disabled.

As noted in section 6.7.2.5, only one function may be performed by a given **TRIGGER** input at a given time.

6.7.2.5 STOP [0271] (IMMEDIATE)

This command tells the 430 to decelerate to a stop and terminate the sequence.

6.7.2.6 KILL [0272] (IMMEDIATE)

This command instructs the 430 to stop sending pulses to the motor immediately and terminate the sequence.

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6.8 POSITION TRACKING COMMANDS

The Position Tracking commands are summarized in Table 6-5. These commands require an encoder. Position tracking may be used any or all of 3 ways:

1. Encoder referenced positioning

2. Motor stall detection

3. Position maintenance.

6.8.0.1 ENCODER REFERENCED POSITIONING

Encoder referenced positioning allows incremental and absolute moves to be made using the encoder's resolution. Commands 53 and 54, which make an incremental or absolute encoder referenced move, require distance parameters to be specified in encoder units. A standard Compumotor 1000 line encoder mounted on the motor shaft would use 4000 encoder steps per revolution.

The move distance is calculated internally by multiplying the move distance (in post-quadrature encoder steps) times the motor resolution to encoder resolution ratio. So a move of 4000 encoder steps with a motor resolution to encoder resolution ratio of 6.250:1 would cause the indexer to calculate a move distance of 25,000 motor steps.

$$25{,}000 = 6.250 * 4000$$

The indexer then executes a move of 25,000 motor steps. Post move position correction will be made only if POSITION MAINTENANCE is enabled. POSITION MAINTENANCE WILL ALSO CORRECT THE MOTOR POSITION IF THE MOTOR STALLS. A stall may be detected by enabling one of the various "do function upon stall" commands, such as ENABLE MOVE TERMINATION ON STALL DETECT (Command [0025]).

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6.8.0.2 MOTOR STALL DETECTION

This feature may be enabled by two commands:

Command	Description
[0015]	Turn on output on stall detect (Option 8)
[0025]	Enable move terminate on stall detect

These commands allow the discontinuation of a move in progress, or turning on a programmable output bit upon detecting a motor stall. Using a 1.8 degree step motor such as those used with Compumotor's M-Series, the motor stalls completely after its lag angle exceeds 3.6 degrees. The 430 indexer can detect this by comparing the motor's desired position to its actual position as shown by the encoder. It does this whether or not the motor is moving. If the *motor is not moving, a stall may* be induced by forcing the motor shaft to turn.

Stalls are not detected if Commands **[0015]** or **[0025]** have not been issued.

6.8.0.3 POSITION MAINTENANCE

This causes the 430 to maintain the motor's desired position. With position maintenance enabled, should the motor shaft be displaced from its desired position, the 430 will attempt to correct the positional error at the rate determined by the Maximum Correction Velocity (Command **[0179]**) and the Correction Gain Factor.

In the event that the motor stalls near its desired position, position correction will take very little time. If the motor stalls a large distance from its desired position, the motor could take a long time to move to the correct position, as it will move at the Maximum Correction Velocity.

Should TERMINATION UPON STALL DETECT be enabled (Command **[0025]**and a stall occur during a move, the motor's current position will become

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the motor's desired position and position maintenance will be performed as a result of that stall. Of course, the motor would maintain its new desired position.

6.8.0.4 OPEN LOOP MOVES

While position maintenance is enabled OPEN-LOOP MOVES may not be commanded. Commands for open loop moves while Position Maintenance is enabled will be ignored. Stall detection, however, may be enabled for encoder referenced moves or open-loop moves.

6.8.1 ENABLE POSITION MAINTENANCE **[0024](000b)** (IMMEDIATE, SEQUENTIAL, SAVED)

Number of Data Words: 1

R2 = 0000 - deactivate
= 0001 - activate

FUNCTION

This command turns post-move Position Maintenance ON or OFF. After power-up or **RESET** this function is OFF unless the RECALL PROGRAM FROM MEMORY ON POWER-UP function is activated and Position Maintenance is implemented in the commands saved in memory.

Position Maintenance is the primary closed-loop function. When Position Maintenance is enabled, the Indexer attempts to maintain the last programmed encoder position. After that, the encoder position maintained is the sum of the closed-loop moves that have been executed.

Open-loop moves (except for the open-loop GO HOME move) cannot be executed when Position Maintenance is ON.

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6.8.2 ENABLE MOVE TERMINATION ON STALL DETECT **[0025](000b)&** (IMMEDIATE, SEQUENTIAL ,SAVED)

Number of Data Words: 1

R2 = 0000 - deactivate
= 0001 - activate

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FUNCTION

This command turns the MOVE TERMINATION ON STALL DETECT function ON or OFF. After power-up or **RESET** this function is OFF unless the **AUTORECALL** function is activated and MOVE TERMINATION ON STALL DETECT is implemented in the commands saved in memory.

The motor resolution and the ratio of motor to encoder resolution must have been defined (Commands **[0176]** and **[0177]**) prior to issuing Command **[0025]**. If this function is ON and a stall is detected, the motor velocity will be immediately zeroed and the current move will be terminated. If Position Maintenance is ON, the position stalled at will become the new desired position. If Position Maintenance is ON and this function is OFF and the motor is stalled during a PRESET move, when the Indexer has put out the nominal number of motor pulses, it will check the Encoder position and detect the discrepancy. At that point, it will move at the Maximum Correction Velocity defined (Command **[0179]**) to the correct position. This may take a long time.

Note

To avoid complications in debugging your system, set and test the motor-to-encoder ratio (Command **[0176]**) before activating the MOVE TERMINATION ON STALL DETECT function.

This command is saved by Command [0291].

6.8.3 SET CLOSED-LOOP OFFSET FROM ZERO **[0047](0b0ddddddddd)** (IMMEDIATE, SEQUENTIAL)

Number of Data Words: 3

R2,R3,R4 = 000d,dddd,dddd- number ofencoderstepsin clockwise direction (1 to 134,217,728 motor steps maximum)

= 010d,dddd,dddd- number of encoder steps in counterclockwise direction (1 to 134,217,728 motor steps maximum)

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This number represents a theoretical maximum. In fact, it is the number of motor steps that *may not* exceed the value. To determine the actual maximum value for encoder steps, the number must be divided by the ratio of motor resolution to encoder resolution used with Command **[0176]**.

Note

The internal quadrature detector will multiply the normal output of the Encoder by four.

FUNCTION

This command defines the present position as an offset from zero (in encoder steps). The highest order digits entered in R2 define the direction of offset. If an absolute position is specified that is outside the legal range, this command is ignored. (To set the current position to zero, use Command **[0048]**.)

6.8.4 EXECUTE CLOSED-LOOP INCREMENTAL MOVE **[0053](0b0ddddddddd)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 3

R2,R3,R4 = 00dd,dddd,dddd clockwise move in encoder steps
= 01dd,dddd,dddd counterclockwise move in encoder steps
(1 to 2,147,483,647 steps)

This number represents a theoretical maximum. In fact, it is the number of motor steps that may not exceed this value. Consequently, to determine the actual maximum value for encoder steps, this number must be divided by the ratio of motor resolution to encoder resolution used with Command **[0176]**.

FUNCTION

This command executes a move of the number of encoder steps specified by the value in registers R2, R3, and R4. If the proper commands defining encoder resolution and related parameters have not been executed (Commands **[0176]** through **[0180]**), this command will be ignored. The Indexer will use the current velocity and acceleration parameters (see Command **[0051]**).

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Note

The internal quadrature detector will multiply the normal output of the Encoder by four.

6.8.5 EXECUTE CLOSED-LOOP ABSOLUTE MOVE **[0054](0b0ddddddddd)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 3

R2,R3,R4 = 00dd,dddd,dddd - clockwise move in encoder steps.
= 01dd,dddd,dddd - counterclockwise move in encoder steps.
(1 to 134,217,728 motor steps maximum)

This number represents a theoretical maximum. In fact, it is the number of motor steps that may not exceed this value. Consequently, to determine the actual maximum value for encoder steps, this number must be divided by the ratio of motor resolution to encoder resolution used with Command **[0176]**.

Note

The internal quadrature detector will multiply the normal output of the Encoder by four.

FUNCTION

This command executes a move to an absolute encoder position specified by the value in registers R2, R3, and R4. If the proper commands defining encoder resolution and related parameters have not been executed (Commands **[0176]** through **[0180]**), this command will be ignored. The Indexer will use the current velocity and acceleration parameters (see Command **[0052]**).

6.8.6 EXECUTE GO HOME CLOSED-LOOP **[0058](000b)&** (DOMINANT, SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 - clockwise search
= 0001 - counterclockwise search

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FUNCTION

This command causes the Indexer to move the motor in search of the CHANNEL Z HOME position at the velocity and acceleration presently defined. If an end-of-travel limit is encountered, the motor will reverse and try searching in the other direction. If the limit switch at the opposite end of travel is encountered, the search for HOME is abandoned.

This command will not be performed unless HOME has been defined with the **[0056]** command. The command will be ignored if the motor is moving, or if the motor is shut down.

The closed-loop HOME position signal is received on the **CHANNEL Z+** and the **CHANNEL Z-** inputs. These inputs are designed to be driven by the index channel signals typically available as an option on incremental encoders. On rotary encoders, this index signal occurs once per revolution. On some linear encoders there are multiple index points. For this reason, the discrete panel **HOME LIMIT** input is active on a closed-loop homing operation, and may be combined with the Z CHANNEL index signal as a means to select one of multiple index signals. This is accomplished by connecting a switch to the **HOME LIMIT** input so that the switch becomes active when the load is in the general area of the desired home point. In this situation, the motor will move until the **HOME LIMIT** input becomes active, then the Indexer will search until the Z CHANNEL index signal also goes active. The Z CHANNEL signal then serves as a fine adjustment for the HOME position, and the **HOME LIMIT** input acts as the coarse adjustment, or as a HOME ENABLE signal. If the **HOME LIMIT** input is not used in this fashion, the polarity of this limit signal must be set using the DEFINE HOME command (Command **[0056]**) or the appropriate internal DIP switch to insure that the HOME ENABLE function does not interfere with the closed-loop GO HOME operation.

6.8.7 Deleted

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6.8.8 DEFINE THE RATIO OF MOTOR STEPS TO ENCODER STEPS
[0176](000ddddd) (000ddddd) (IMMEDIATE, SAVED)

Number of Data Words: 4

R1,R2 = 000d,dddd - the numerator of the ratio (motor) (1 to 65,535)
R3,R4 = 000d,dddd - the denominator of the ratio (encoder) (1 to 65,535)

FUNCTION

For closed-loop operation, the Indexer must know how many motor steps must be output to get back one encoder step. If that whole number includes a fraction, it must be expressed as a ratio of whole numbers. This ratio must be defined for the Indexer to be able to execute any closed-loop operation. To determine the ratio, it is necessary to multiply the encoder resolution by four because of the internal quadrature detector. It will then be necessary to reduce the resulting fraction (motor steps over

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encoder steps) by dividing the motor resolution and encoder resolution by the least common denominator.

For example, the Indexer is set by default to accommodate a directly coupled 1000 line rotary encoder, and a 25,000 step motor. The quadrature detector multiplies this value by four so that the ratio of motor resolution to encoder resolution is 25,000 to 4,000. Reducing this fraction yields the proper entries for the registers above for a ratio of 25 to 4, as follows:

R1 = 0000 R2 = 0025 (00000025)
R3 = 0000 R4 = 0004 (00000004)

Note

The motor resolution must be higher than that of the Encoder for the Position Maintenance function to work. In this operating mode, the system resolution will be set by the Encoder.

6.8.9 DEFINE MOTOR RESOLUTION **[0177](000ddddd)**(IMMEDIATE , SAVED)

Number of Data Words: 2

R2,R3 = 000d,dddd - the motor resolution in steps per revolution

FUNCTION

This command defines the motor resolution for closed-loop operation. This information, along with the number of rotor teeth in the motor (Command **[0180]**), is required to implement the "stall detection" feature of closed-loop operation. In a standard Compumotor motor/drive, the resolution would be 25,000 steps/revolution. The 430 Indexer defaults to this value on power-up.

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6.8.10 DEFINE BACKLASH DEADBAND **[0178](00ddddddddddd)** (IMMEDIATE)

Number of Data Words: 3

R2,R3,R4 = 00dd,dddd,dddd - the backlash deadband in motor steps
(0 to 2,147,483,647)

FUNCTION

The backlash deadband is the number of motor steps required to reverse any deadband in the mechanical system between the motor's shaft and the Encoder. Typically the deadband is due to backlash in a geartrain being driven by the motor. If the Encoder is mounted directly on the motor's shaft, there will be no backlash. The backlash value should not be very large; too large a deadband can result in marginalstall detection capability.

The backlash deadband is defined in motor steps, not encoder steps, and is the entire width of the deadband region. It is the number of motor steps required to get the load moving again following a change of motor direction. The default value for backlash deadband is 0.

6.8.11 DEFINE POSITION MAINTENANCE **[0179](0ddd)(ddddddddddddd)** (IMMEDIATE, SEQUENTIAL, SAVED)

Defaults: Correction gain = 10, Velocity Range = 1
Number of Data Words: 4

R1 = 0ddd - the correction gain constant "K" (0 to 255)
R2,R3,R4 = $d_{12}d_{11}$ddddddddd
d_{12} = the maximum correction velocity range (0 to 7)
d_{11} = the position maintenance algorithm code (1 to 3)
dd,dddd,dddd = the maximum correction velocity
(1 to 2,147,483,647 velocity units)

FUNCTION

The above parameters may be thought of as the servo gain parameters for the positioning servo function called Position Maintenance. Position Maintenance is performed only when enabled (Command **[0024]**) and when a move

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is not being performed. These gain constants are initially set at low default values and will probably operate without adjustment. The speed of the servo response may be improved by increasing the gain constants, at the risk of introducing instability. Any such instability will take the form of overshoot oscillations as the Indexer tries to drive the motor to the designated encoder position. As a rule, the higher gains are set for optimum response. The value in register R1 defines the correction gain constant. If this value is 0, no correction will occur, and a value of 255 will yield maximum correction. The power-up default value of K is 10. The first digit of R2 (d_{12}) is the velocity range number. Default = 1.

d_{12}	Velocity Units	Maximum Velocity (Steps/Sec)	Velocity Resolution (Steps/Sec)
0	Steps/sec	546,133.3000	16.667000
1 *	Steps/10 sec	54,613.3300	1.666700
2	Steps/100 sec	5,461.3330	0.166670
3	Step/1000 sec	546.1333	0.016667
4	Steps/min	9,102.2220	0.277780
5	Steps/1/2 sec	1,092,266.6700	33.333000

The second digit of R2 (d_{11}) defines the Position Maintenance algorithm. The three algorithms to choose from are:

"1" - correction velocity = K times error in position
"2"*- correction velocity = K times square root of error
"3" - correction velocity = K times error squared

Entries of 0 or 4 through 9 for d_{11} invalidate the command. The power-up default value of this entry is algorithm #2.

The last two digits of R2 along with all of R3 and R4 define the correction velocity in steps per second. The power-up default value for the maximum correction velocity is 25,000 steps/sec.

*Default setting

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6.8.12 DEFINE ROTOR TEETH **[0180](000ddddd)** (IMMEDIATE)

Number of Data Words: 2

R2,R3 = 000d,dddd - the number of rotor teeth (1 to 65,535)

FUNCTION

This command defines the number of rotor teeth on the motor being driven. The number is required if the stall detection function is used. The default value for this number is 50, corresponding to a 1.8-degree permanent magnet motor. A stall is detected when the discrepancy between encoder position versus motor position indicates that the motor has "slipped a tooth", after the backlash parameter (Command **[0178]**) has been taken into account.

6.8.13 DEFINE SIGNAL DEADBAND **[0181](000ddddd)** (IMMEDIATE, SEQUENTIAL)

R2,R3 = 000dd,ddd - the magnitude of allowable deviation in encoder steps (0 to 65,535)

This command defines a window of allowable deviation of motor position with respect to encoder position. It is used exclusively with Command **[0015]** (Turn ON/OFF output on condition) for the purpose of generating a signal when this condition occurs. This parameter and this command are completely independent of Commands **[0178]** (Define Backlash Deadband) and **[0167]** (Turn on output on stall), which have a similar function. The latter two commands would be used with Command **[0025]** (Enable Move) Termination on Stall Detect) to halt operations in the event of a catastrophic position loss. This command could be incorporated to indicate when such an event is impending, or when the motor is applying some fraction of its rated torque. When the difference between the desired motor position as measured by the number of steps sent to the drive and the actual position as measured with encoder feedback exceeds the specified parameter, the designated output is turned on.

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6.8.14 DEFINE A CLOSED-LOOP INCREMENTAL MOVE **[0212](00DD)(0bddddddddddd)&** (IMMEDIATE)

Number of Data Words: 4

R1 = 00dd - the move number (1 to 40)
R2,R3,R4 = 00ddddddddddd - clockwise move in encoder steps
= 01ddddddddddd - counterclockwise move in encoder steps
(1 to 2,147,483,647 encoder steps)

This number represents a theoretical maximum. In fact, it is the number of motor steps that may not exceed this value. Consequently, to determine the actual maximum value for encoder steps, this number must be divided by the ratio of motor resolution to encoder resolution used with Command **[0176]**.

FUNCTION

This command will define a move whose distance and direction are entered in registers R2 through R4 in encoder steps and assign to it the move number in R1. If the specified distance is long enough, the move profile will be trapezoidal, where the motor will be accelerated at the previously established rate. Deceleration will occur at the same rate in time to allow stopping at the designated position. If the distance is too short, the move profile will be triangular. Acceleration and velocity parameters are established using Commands **[0261]** and **[0262]** or by default settings of the internal DIP switches. This command predefines a move which may be executed later by number using the ***PERFORM A MOVE*** command (Command **[0064]**). A move number of 0000 is illegal and will be ignored. The values in registers R2, R3, and R4 specify the travel distance in encoder steps, not motor steps. In addition, the factor of four multiplication of the Encoder's quadrature signal must be included or the motor will only go one-fourth the desired distance. The first two digits of R2 specify the direction of the move. Values other than 00 or 01 will cause this command to be ignored.

The digits in registers R2 through R4 specify the direction and distance to be traveled relative to the current position. A distance of zero is illegal and may not be specified. All of the registers must contain viable information in order for a incremental move to be defined. Redefinition of a move is possible only by reissuing the complete DEFINE A MOVE command

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This and the other DEFINE A MOVE commands are used to build a "library" of PREDEFINED MOVES that may be accessed by number and used to build PREDEFINED SEQUENCES. Both the PREDEFINED MOVES and PREDEFINED SEQUENCES may be saved for later recall. If too many moves and sequences are defined and memory cannot hold any more commands, the **READY** output will go high (false) and no more commands will be accepted.

Note

A move defined by this command can be performed only after the ratio of motor to encoder pulses has been defined. It is not possible to execute this command or other closed-loop moves unless the Position Maintenance function is active.

6.8.15 DEFINE A CLOSED-LOOP ABSOLUTE MOVE **[0213](00dd)(0bddddddddddd)&** (IMMEDIATE)

Number of Data Words: 4

R1 = 00dd - move number (1 to 40)
R2,R3,R4 = 00ddddddddddd - clockwise move in encoder steps
= 01ddddddddddd - counterclockwise move in encoder steps

This number (9,999,999,999) represents a theoretical maximum. In fact, it is the number of motor steps that may not exceed this value. Consequently, to determine the actual maximum value for encoder steps, this number must be divided by the ratio of motor resolution to encoder resolution used with Command **[0176]**.

FUNCTION

This command is similar to the DEFINE A CLOSED-LOOP RELATIVE MOVE command (Command **[0212]**) with the exception that the indicated direction information refers only to which side of the zero position the specified location is on, and that the number of encoder steps designated refers to the distance from the zero position and not from the current position. Following execution of this command, the move specified may be executed by number using the PERFORM A MOVE command (Command **[0064]**). The first two

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digits of register R2 specify on which side of the zero position the move should finish. Values other than 00 or 01 here will cause this command to be ignored. All of the registers must contain viable information in order for a incremental move to be defined. Redefinition of a move is allowed only by reissuing the complete DEFINE A MOVE command.

This and the other DEFINE A MOVE commands are used to build a "library" of PREDEFINED MOVES that may be accessed by number and used to build PREDEFINED SEQUENCES. Both the PREDEFINED MOVES and PREDEFINED SEQUENCES may be saved in permanent memory for later recall. If too many moves and sequences are defined and memory cannot hold any more commands, the **READY** output will go high (false) and no more commands will be accepted.

6.9 PROGRAMMING AND STORE COMMANDS

The Programming and Store commands are summarized in Table 6-6. These commands can be grouped as follows:

a. PREDEFINED MOVE Commands (**[0200], [0203], [0206], [0215],** 6.9.1)

b. PREDEFINED SEQUENCE Commands (**[0216],[0217], [0218],** 6.9.2)

c. SAVE PROGRAM (in Permanent Memory) Command (**[0291],** 6.9.3)

d. RECALL PROGRAM FROM (Permanent) MEMORY Command (**[0292],** 6.9.4)

e. ENABLE AUTORECALL ON POWER-UP Command (**[0293**], 6.9.5)

6.9.1 PREDEFINED MOVE COMMANDS

The following subsections describe the commands for definition or deletion open-loop PREDEFINED MOVES. Closed-loop PREDEFINED MOVE programming commands were described in sections 6.8.13 and 6.8.14.

These commands are used to build a library of PREDEFINED MOVES. A total of 40 moves can be stored. If there is insufficient memory capacity left to store additional moves (and sequences), no more commands will be accepted and the **READY** output (Terminal 24) will go high (false).

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6.9.1.1 DEFINE AN INCREMENTAL MOVE **[0200](00dd)(0bddddddddddd)&** (IMMEDIATE)

Number of Data Words: 4

R1 = 00dd - move number (1 to 40)
R2,R3,R4 = 00ddddddddddd - clockwise move in motor steps
= 01ddddddddddd - counterclockwise move in motor steps
(1 to 2,147,483,647 steps)
A distance of 0 steps is an illegal value.

FUNCTION

This command will define a move indexed to the current position whose distance and direction are entered in registers R2 through R4 and assign to it the move number in R1. If the specified distance is long enough, the move profile will be trapezoidal, where the motor will be accelerated at the previously established velocity. Deceleration will occur at the same rate in time to allow stopping at the designated position. If the distance is too short, the profile will be triangular. Acceleration and velocity parameters are established using Commands **[0261]** and **[0262]**, or by default settings of the internal DIP switches. This command predefines a move which may be executed later by number using the PERFORM A MOVE command (Command **[0064]**). A move number of 0000 is illegal and will be ignored. Values other than 00 or 01 in the first 2 positions of R2 (Bits 10, 11) will cause this command to be ignored. All of the registers must contain viable information in order for an incremental move to be defined. Redefinition of a move is possible only by reissuing the complete DEFINE A MOVE command. Only one move may be assigned to a given number at any time.

6.9.1.2 DEFINE AN ABSOLUTE MOVE **[0203](00dd)(0bddddddddddd)&** (IMMEDIATE)

Number of Data Words: 4

R1 = 00dd - move number (1 to 40)
R2,R3,R4 = 00ddddddddddd - clockwise move
= 01ddddddddddd - counterclockwise move (1 to 134,217,728)
A distance of 0 steps is an illegal value.

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Absolute positions can be defined only within the range -134,217,728 through +134,217,728. An absolute position specified outside of this range is invalid. If the motor is situated outside of this range, one must perform an incremental distance move to return within the range before an absolute move can be executed.

FUNCTION

This command will define a move indexed to a zero position whose distance and direction are entered in registers R2 through R4 and assign to it the move number in R1. The indicated direction information refers to which side of the zero position the specified location is on. The number of motor steps designated refers to the distance from the zero position. If the specified distance is long enough, the move profile will be trapezoidal, where the motor will be accelerated at the previously established velocity. Deceleration will occur at the same rate in time to allow stopping at the designated position. If the distance is too short, the profile will be triangular. Acceleration and velocity parameters are established using Commands **[0261]** and **[0262]** or by default settings of the internal DIP switches.

Following the execution of this command, the move specified may be executed by number using the PERFORM A MOVE command (Command **[0064]**). The first two digits of register R2 specify on which side of the zero position the move should finish. Values other than 00 or 01 here will cause this command to be ignored. All of the registers must contain viable information in order for a incremental move to be defined. Redefinition of a move is possible only by reissuing the complete DEFINE A MOVE command.

6.9.1.3 DEFINE A CONTINUOUS MOVE **[0206](00dd)(000b)&** (IMMEDIATE)

Number of Data Words: 2

R1 = 00dd - move number (1 to 40)
R2 = 0000 - clockwise direction
= 0001 - counterclockwise move

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FUNCTION

This command will define the move referenced by R1 as a continuous move to be performed by the PERFORM A MOVE command (Command **[0064]**). A move number of 0000 is illegal and will be ignored. All of the registers must contain viable information in order for a continuous move to be defined. Redefinition of a move is allowed only by reissuing a complete DEFINE A MOVE command.

A continuous move is an excursion from one velocity to another velocity. The goal of a continuous move is to get from the current velocity to a new velocity. The Indexer assumes that the move is complete when the designated velocity set with Command **[0261]** or the internal DIP switches has been reached. At that point, the Indexer will accept a new CONTINUOUS MOVE command to change speed.

6.9.1.4 DELETE A MOVE **[0215](00dd)** (IMMEDIATE)

Number of Data Words: 1

R1 = 00dd - move number to delete (1 to 40)

FUNCTION

This command deletes the move referenced by R1 from the library of *PREDEFINED MOVES*.

6.9.2 PREDEFINED SEQUENCE COMMANDS

The following subsections describe the commands for definition or deletion of PREDEFINED SEQUENCES.

These commands are used to build a library of PREDEFINED SEQUENCES. A total of 15 sequences can be stored. The sequences can include (call) PREDEFINED MOVES. The sequences can include other PREDEFINED SEQUENCES. If there is insufficient memory capacity to store additional sequences (and moves), no more commands will be stored and the **READY** output (Terminal 24) will go high (false).

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6.9.2.1 END THE SEQUENCE DEFINITION [0216] (IMMEDIATE)

Number of Data Words: None

FUNCTION

This command indicates that the last command to be stored in the PREDEFINED SEQUENCE has been transmitted (see Command [0217]).

6.9.2.2 BEGIN THE SEQUENCE DEFINITION [0217](00dd) (IMMEDIATE)

Number of Data Words: 1

R1 = 00dd - sequence number (1 to 15)

FUNCTION

This command starts definition of a PREDEFINED SEQUENCE. The value in register R1 is the identification number assigned to this particular sequence. A sequence number outside the above range will cause this command to be ignored. Every command sent following this one is considered a candidate for the sequence except END THE SEQUENCE DEFINITION and PERFORM THE TEST MOVE (Commands [0216] and [0255]). All other commands entered following this one are not executed immediately; instead, they are incorporated into the PREDEFINED SEQUENCE if they are valid SEQUENTIAL commands. If they are not valid SEQUENTIAL commands, they are ignored. No commands can be performed (except the above exceptions) while the sequence is being defined.

The END THE SEQUENCE DEFINITION command must be issued to complete definition of the PREDEFINED SEQUENCE, and to restore the Indexer to normal operating mode.

6.9.2.3 DELETE A SEQUENCE [0218](00dd) (IMMEDIATE)

Number of Data Words: 1

R1 = 00dd - sequence number to delete (1 to 15)

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FUNCTION

This command deletes the PREDEFINED SEQUENCE referenced by R1 from the library of sequences. This command will typically be used to create new space in memory when an old PREDEFINED SEQUENCE is no longer required.

6.9.3 SAVE PROGRAM [0291] (DOMINANT)

Number of Data Words: None

CAUTION

You need to be very careful when you use the **SAVE** command to avoid unintentional changes of the information stored in permanent memory. **SAVE** changes the entire contents of permanent memory to match the current contents of the working memory. If working memory is blank, **SAVE** will blank the permanent memory.

FUNCTION

This command saves the present contents of the Indexer's operating memory in the permanent memory. The following information is saved by this command:

SHUTDOWN input - enabled or disabled	(Command [0019])
Direction Definition - normal or reversed	(Command [0020])
Position Maintenance - enabled or disabled	(Command [0024])
Stall Detection - enabled or disabled	(Command [0025])
HOME definition - polarity and "edge"	(Command [0056])
Ratio of motor to encoder steps	(Command [0176])
Motor resolution	(Command [0177])
Backlash deadband	(Command [0178])
Position maintenance parameters	(Command [0179])
Start/Stop Velocity	(Command [0214])
Current velocity and acceleration	(Command [0261],[0262])
JOG velocity and acceleration	(Command [0281],[0282])
All currently defined sequences	
All currently defined moves	
Recall Program from Memory on Power-up - enabled or disabled	(Command [0293])

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This command will be ignored if the motor is moving. The SAVE operation may take as much as 20 seconds to complete, and the Indexer will not respond to or perform other commands during this time.

Commands which enable stall detection and position maintenance are not saved and must be reissued after reset or power-up to be valid.

6.9.4 RECALL PROGRAM FROM MEMORY **[0292]** (DOMINANT)

Number of Data Words: None

FUNCTION

This command loads the contents of the permanent memory into the working memory. When a RECALL PROGRAM FROM MEMORY command is entered after a SAVE command, the operating information in memory at the time the last SAVE command was issued will be restored.

The information loaded by this command is detailed in the description of the SAVE PROGRAM command (Command **[0291]**). This operation may be executed automatically at power-up by use of Command **[0293]**.

A RECALL command will be ignored if the motor is moving.

6.9.5 ENABLE AUTORECALL ON POWER-UP **[0293](000b)** (DOMINANT)

Number of Data Words: 1

R2 = 0000 function disabled
= 0001 function enabled

FUNCTION

This command allows automatic loading of the contents of the Indexer's permanent memory into its independent working memory whenever power is switched ON. When a RECALL PROGRAM FROM MEMORY is executed after a SAVE

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command, the operating information in memory at the time the last SAVE command was issued will be restored.

The information loaded by this command is detailed in the description of the SAVE PROGRAM command (Command **[0291]**) above.

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A SAVE or RECALL command will be ignored if the motor is moving.

This function is enabled on units from the factory. When the AUTORECALL function is disabled, the state of the 430 Indexer on power-up will be the following:

SHUTDOWN input - enabled	(Command **[0019]**)
Direction Definition - normal	(Command **[0020]**)
Position Maintenance - disabled	(Command **[0024]**)
Stall Detection - disabled	(Command **[0025]**)
HOME definition - internal DIP switches	(Command **[0056]**)
Ratio of motor to encoder steps - 25:4	(Command **[0176]**)
Motor resolution - 2500	(Command **[0177]**)
Backlash deadband - 0	(Command **[0178]**)
Position maintenance parameters - 1, 2, 204.8	(Command **[0179]**)
Start/Stop Velocity - 0	(Command **[0214]**)
Current velocity and acceleration - internal DIP switches	(Command **[0261]**, **[0262]**)
JOG velocity and acceleration - 2,500 max.	(Command **[0281]**, **[0282]**)

Refer to section 3.7 for details on the location and setting of the internal DIP switches.

6.10 GENERAL PURPOSE COMMANDS

The General Purpose Commands are summarized in Table 6-7 and described in the subsections that follow.

6.10.1 NULL COMMAND **[0000]** (IMMEDIATE)

Number of Data Words: None

FUNCTION

This command may be used to replace a deleted command in a series of commands without affecting Indexer operation. This command has no operational effect.

6.10.2 OUT1, OUT2 CONTROL

These commands turn the programmable outputs **OUT1** (Terminal 30) and **OUT2** (Terminal 31) ON and OFF.

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6.10.2.1 TURN ON AN OUTPUT **[0011](000d)** (IMMEDIATE, SEQUENTIAL)

R1 = 0001 - OUT1 ON
= 0002 - OUT2 ON

FUNCTION

This command turns on the specified programmable output. R1 indicates which output is to be set ON. The two outputs are labeled 1 and 2; therefore, R1 may be 0001 or 0002. Any number other than 0001 or 0002 is considered incorrect and the command will be ignored. After power-on or **RESET**, both outputs are OFF.

6.10.2.2 TURN OFF AN OUTPUT **[0012](000d)** (IMMEDIATE, SEQUENTIAL)

Number of Data Words: 1

R1 = 0001 - OUT1 OFF
= 0002 - OUT2 OFF

FUNCTION

This command turns off the specified programmable output. R1 indicates which output is to be set OFF. Any number other than 0001 or 0002 is considered incorrect and the command will be ignored.

6.10.2.3 TURN ON/OFF BOTH OUTPUTS **[0013](000d)** (IMMEDIATE, SEQUENTIAL)

R1 = 0000 - Turn OFF both OUT1 and OUT2
= 000 2 - Turn OUT1 ON and OUT2 OFF
= 000 4 - Turn OUT1 OFF and OUT2 ON
= 000 6 - Turn ON both OUT1 and OUT2

FUNCTION

This command is identical in function to Commands **[0011]** and **[0012]** except that both outputs are controlled with one command. Commands **[0011]** and **[0012]** are preferred in situations where one or both outputs are dedicated to a specific function as with Commands **[0015]** or **[0167]**, for example.

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6.10.2.4 TURN ON/OFF OUTPUT ON CONDITION **[0015](0ddd)(000b)(000b)** (IMMEDIATE, SEQUENTIAL, SAVED

R1 = Condition used to determine output state

0000 - Null (disable output on condition)
0001 - Motor moving = ON (not moving = OFF)
0002 - Dominant command in process = ON (or not in process = OFF)
0003 - Sequence in process = ON (not in process = OFF)
0005 - Motor is accelerating = ON (not accelerating = OFF)
0006 - Motor is decelerating = ON (not decelerating = OFF)
0007 - Motor is at constant nonzero velocity = ON (not at constant nonzero velocity = OFF)
0128 - Motor position is within closed loop deadband*
0008 - Turn on output on stall*

R2 = Signal Polarity

0000 - Active - high
0001 - Active - low

R3 = Output Selection

0001 - OUT1 is used
0002 - OUT2 is used

FUNCTION

This command allows either or both Programmable Outputs to be dedicated to indicate one of the conditions detailed above. Following this command, the designated output will indicate the designated condition at all times until the output is reassigned. Use of the Null condition (0000 in R1 above) disables this command. Either output may indicate only one condition at a time.

* Encoder connection required, see Command **[0181]**

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Example: The operator needs the 430 to indicate when it has finished executing a sequence. He gives the 430 the following command:

R1	R2	R3	R4	COMMAND
0003	0001	0002		0015

Subsequently, output **OUT2** will be low while a sequence is executing and will go high when it has finished.

6.10.3 REMOTE POWER SHUTDOWN CONTROL

This command controls whether the discrete input (Terminal 32) or Command **[0018]** is enabled. The command can turn off the current to the motor winding. When the current is shut OFF, the holding torque of the motor is absent and the motor shaft is free to rotate. There are two mutually exclusive ways to establish control of the REMOTE POWER SHUTDOWN function.

a. Use Command **[0019]** to enable the discrete input **SHUTDOWN** (Terminal 32). The discrete input can then be used to turn the motor current ON and OFF, or

b. Use Command **[0019]** to enable Command **[0018]** (which disables the discrete input). Command **[0018]** can then be used to control the motor current.

6.10.3.1 TURN ON ACTIVATE REMOTE POWER SHUTDOWN **[0018](000b)** (SEQUENTIAL) (IMMEDIATE)

Number of Data Words: 1

R2 = 0000 - function OFF
= 0001 - function ON

FUNCTION

This command turns ON or OFF the current to the motor's windings, removing holding torque. This command will have no effect if the motor is moving.

After REMOTE POWER SHUTDOWN (RPS) is turned ON, no moves may be executed until REMOTE POWER SHUTDOWN is turned OFF. After power-on or **RESET**, REMOTE POWER SHUTDOWN is OFF. Command **[0019]** must be activated before this command is allowed, i.e., on power up, discrete R.P.S. is enabled, Command **[0018]** is disabled.

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6.10.3.2 SELECT REMOTE SHUTDOWN INPUT **[0019](000b)** (SEQUENTIAL)

Number of Data Words: 1

R2 = 0000 - enable discrete R.P.S. input (terminal 32), disable Command **[0018]**
= 0001 - enable Command **[0018]**, disable discrete input. On power up command 0018 is disabled.

FUNCTION

This command selects either the discrete input (Terminal 32) or command **[0018]** for control of REMOTE POWER SHUTDOWN.

6.10.4 SET THE DEFAULT POSITION PARAMETER **[0280](00ddddddddddd)** (IMMEDIATE)

R2,R3,R4 = 00dd,dddd,dddd - the position parameter (1 to 2,147,483,647 motor steps)

The stated maximum number of motor pulses applies to incremental moves. If this parameter is to be used as an absolute position (implemented via the **ABSOLUTE** input) its value must not exceed 134,217,728 steps.

FUNCTION

This command will define a default position parameter in motor steps to replace the one normally obtained by reading the internal DIP switches on power-up. This parameter is used by the Indexer to execute the move controlled by the front panel **START** input when the **PRESET** input is active, and no data is on the inputs **BIT 0** through **BIT 15**. The values in registers R2, R3, and R4 specify the travel distance in motor steps. A distance of zero is illegal and may not be specified. All of the registers must contain viable information for the parameter to be valid.

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6.10.5 DEFINE THE SPECIAL INPUT [0301](000d) (DOMINANT)

Number of Data Words: 1

R1 = 000d - the input Data Assignment Register (0 to 4)
0000 = command strobe
0001 = Register 1 (DS1)
0002 = Register 2 (DS2)
0003 = Register 3 (DS3)
0004 = Register 4 (DS4)

FUNCTION

This command sets up the **SPECIAL** input to allow execution of complex predefined operations with minimum transactions on the data line (**BIT 0** to **16**) and **STROBE** inputs. When this command is entered, the Indexer expects another command to follow it. The Indexer will store the next command to be executed whenever the **SPECIAL** input goes active. Five "words," four BCD digits each, can be saved, including the four Data Registers, R1 through R4, and the command word. The order of entry of the five words is not important.

The **SPECIAL** input may be used as a substitute discrete command, eliminating the need to activate the data inputs and associated strobes to effect execution.

After the **SPECIAL** input is assigned to a command, when the input goes active, the Indexer reads whatever is on the data inputs, and assigns that data word to one of the four registers used by the assigned command, or it may even take the command number itself from the data inputs. The contents of register R1 at the time this command is entered will tell the Indexer how to interpret whatever is on the data inputs at the time the **SPECIAL** input goes active. Values stored by this command are used for the other four words of the defined SPECIAL command.

This feature would allow direct connection of four thumbwheel switches or similar data input devices for selection of operating parameters at run time without multiple strobes.

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After a **RESET** or following power-on, the **SPECIAL** input default function will be PERFORM A SEQUENCE (Command **[0065]**), and the value on the 16 data inputs is assigned to register R1 as the number of the sequence to be executed. A zero value on the **DATA** inputs will cause the **SPECIAL** input to be ignored.

Note

A similar function is implemented for the **START** input for the execution of PREDEFINED MOVES.

6.10.6 LIST PROGRAM **[0311]** (DOMINANT)

This command is supplied for use with any serial communications (RS-232) device that is used to program the Indexer. If the Indexer is in Serial Programming mode and this command is received, the Indexer will output a report detailing all PREDEFINED MOVES and SEQUENCES in memory. PREDEFINED MOVES are displayed with all their parameters, PREDEFINED SEQUENCES show a list of the commands by number (in decimal), with all command parameters displayed in hexadecimal notation.

The example below shows the output generated by this command when the 430 has been programmed with the example commands from section 4.3. The boldface entries are hexadecimal numbers. The numbers not boldfaced are decimal numbers.

For a detailed description of the hexadecimal parameters, refer to Compumotor's 1811 Indexer Manual. Since the 1811 uses many of the same commands as the 430, this will help decode the hexadecimal. The command numbers are listed in the 1811 manual in hexadecimal, so that the 430 command must be changed to hexadecimal prior to looking it up in the 1811 manual. For example, Command **[0015]** in the 430 is Command **[0F]** in the 1811.

AR and VR refer to Velocity and Acceleration ranges.

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```
Move Definitions:
Num Type   Distance    VR  Velocity  AR Acceleration

  2  200      +107777  0     100000  0    1000000
  4  200       -88888  0     200000  0     700000
  8  203           +0  0     150000  0     100000

SEQUENCE BUFFERS:

SEQUENCE BUFFER NUMBER  8:

116 01 01 00
 32 0A 00 05
 64 02
 44 02 01
 64 04
 64 04
 44 03 01
 11 01
 11 02
 42 00 02
 12 02
 12 01
 64 08
```


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The first section of this output listing shows the parameters for predefined moves numbers 2, 4, and 8. The second section lists the commands assigned to Sequence number 8 in order, by command number.

6.10.7 TURN ON/OFF BOOST **[0027](000d)** (IMMEDIATE, SEQUENTIAL)

R2 = 0000 - Turn OFF BOOST
0001 - Turn ON BOOST

This command turns on the BOOST output (Terminals 57, 58)

It is supplied for use with Compumotor Drivers that have an input for **BOOST.** This feature is intended to allow a temporary increase in drive current to the Motor for increased torque. Boosting results in a 20 to 25% percent increase in torque, and also accelerated motor heating. The **BOOST** function must not be left on for more than 20 seconds. Active cooling for motor and drive should be implemented when **BOOST** is used.

6.10.8 TURN ON/OFF AUTOMATIC BOOST **[0029](000d)** (IMMEDIATE, SEQUENTIAL)

R2 = 0000 - Disable AUTOMATIC BOOST
0001 - Enable AUTOMATIC BOOST

This function can be used to automatically generate a **BOOST** output (Terminals 57, 58) to the motor/drive whenever it is being accelerated or decelerated. If the motor is decelerating to a stop, the **BOOST** output is turned off R2, R3 milliseconds after the stop to allow for settling. This function is disabled following a reset.

6.10.9 TURN ON/OFF DRIVE RESET **[0026](000d)** (IMMEDIATE)

R2 = 0000 - Turn OFF DRIVE FAULT RESET
0001 - Turn ON DRIVE FAULT RESET

This command is supplied for use with Compumotor drives that have an input for **FAULT RESET.** It turns on and off the FAULT RESET OUTPUT (Terminals 53, 54).

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6.10.10 TURN ON/OFF GEARSHIFT **[0028] (000d)** (IMMEDIATE)

R2 = 0000 - Turn OFF GEARSHIFT
0001 - Turn ON GEARSHIFT

This command turns on and off the GEARSHIFT output (Terminals 55, 56). This will cause Motor/Drives which support GEARSHIFT, such as Compumotor's P-Drive, to change motor resolution. This is generally used to select a high motor resolution for positioning and a low motor resolution for high speed operation.

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NOTES

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Appendix A

PROGRAMMING THE MODEL 430 WITH THE MODEL 431

A.1 DESCRIPTION

The Model 431 Input Panel is designed to plug directly into the Model 430 Indexer parallel programming interface terminals. Four thumbwheel switches provide the required BCD switch closures to **GROUND** to enter 430 data and commands. Five momentary switches provide both the data strobe signals required to enter data into the 430's internal data registers and the command strobe signal necessary to enter a command. Two 431 output connectors are provided. One connector allows for "low true" BCD interface signals, the other for "high true," thus allowing a match with programmable controllers.

> Note
>
> If the "high true" configuration is used, it is necessary to set the 430 for high true with Model 430 internal DIP switch SW5-4.

A.2 CONNECTION

Plug the connector end of the supplied ribbon cable into the appropriate connector on the 431. Use the "low true" connector if there is no requirement for "high true" data. Connect the other end to 430 screw terminals 1 through 22 so that the signal names match at each end of every wire in the cable. Be sure that the **CW** and **CCW LIMIT** terminals are still connected to the **GROUND** terminal.

A.3 PROGRAMMING

Refer to Chapters 5 and 6 for more details on programming. To enter a command, it is first necessary to load any data that the command requires. This is done by setting the thumbwheels to the appropriate value and activating the appropriate data strobe switch. The data strobe switches, DS1 through DS4, cause the Indexer to read the thumbwheel data and store it

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internally in a corresponding register. Register data is used by the 430 whenever it executes a command (if the particular command requires data).

Commands are entered for execution by dialing up the command number on the thumbwheels and activating the command strobe switch (**CMD STB**).

Example 1: Make a 25,000-step/rev motor move clockwise one revolution at the current velocity and acceleration.

The operator would use Command [0051], **PERFORM AN INCREMENTAL MOVE**, for this move.

The command description in section 6.6.2.2 describes the data that must be entered for this command. This data consists of a 12-digit long number that specifies the direction of the move and distance in motor steps. In this example, the value required is

000000025000

For entry, the number is broken into three parts of four digits each to be loaded into internal 430 data registers R2, R3, and R4, as follows:

R2	R3	R4
0000	0002	5000

When the Indexer is instructed to execute the command, it will fetch these values and chain them together to reconstruct the 12-digit number.

A.4 LOADING THE EXAMPLE COMMAND

The three values in Example 1 must be loaded prior to entering the command identification number. (They need not be loaded in any particular order.) Proceed as follows:

>> Set the 431 thumbwheels to **0000**

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>> Press switch **DS2** to load this number into register R2
>> Set the 431 thumbwheels to **0002**
>> Press switch DS3 to load this number into register R3
>> Set the 431 thumbwheels to **5000**
>> Press switch DS4 to load this number into register R4

The above steps load data. The next step is to enter the Command Identification Number.

>> Set the thumbwheels to the command number, **0051**
>> Press the **CMD STB** (command strobe) switch

The motor will rotate one revolution.

Once the data is loaded, it remains there. As long as the thumbwheels are set to **0051**, the Indexer will repeat this move each time the **CMD STB** switch is operated.

Example 2: Reverse the direction of motion selected in Example 1.

Changing the direction control digit in register R2 will reverse the direction function.

>> Set the 431 thumbwheels to **0100**
>> Press switch **DS2** to load this number into register R2

The contents of internal data register R2 have been changed from 0000 to 0100. The 12-digit number in the 430 working memory is now

010000025000

Set the thumbwheels back to 0051 and press the **CMD STB**. The motor will rotate in the reverse direction each time **CMD STB** is pressed.

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Example 3: Change the move from one to five revolutions (from 25,000 to 125,000 steps).

The position data can be changed by altering the data in register R3 from 0002 to 0012.

>> Set the thumbwheels to **0012**

>> Press **DS3** to load this number into R3

The data in working memory is now

010000125000

and the motor shaft will rotate five revolutions each time **CMD STB** is pressed.

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Appendix B

DIAGNOSTIC PROGRAM

The 430 is supplied with some preprogrammed functions to assist in testing. These include three predefined moves and one Sequence as detailed in Section 2.5 of the Operator's Manual. The moves are defined as numbers 2, 4, and 8, the Sequence is assigned number 8. The command and data values entered into the 430 to load these operations are listed below. Strobes "1" through "4" refer to DATA STROBE 1 through DATA STROBE 4, "C" refers to the COMMAND STROBE. The BCD value accompanying the COMMAND STROBE is the command number. Refer to the Command Description for details on each command by number.

REGISTER CONTENTS

Entry	BCD value	Strobe	R1	R2	R3	R4	
			0000	0000	0000	0000	
1	0100	3	0000	0000	0100	0000	(load R3)
2	0262	C	*this command defines the acceleration parameter as 1,000,000 steps/sec/sec				
3	0010	3	0000	0000	0010	0000	(load R3)
4	0261	C	*this command defines the velocity as 100,000 steps/sec				
5	0002	1	0002	0000	0010	0000	(load R1)
6	7777	4	0002	0000	0010	7777	(load R4)
7	0200	C	*this command defines Move #2 as 107,777 steps clockwise				
8	0000	1	0000	0000	0010	7777	(load R1)
9	0000	4	0000	0000	0010	0000	(load R4)
10	0700	3	0000	0000	0070	0000	(load R3)
11	0262	C	*this command defines the acceleration parameter as 700,000 steps/sec/sec				
12	0020	3	0000	0000	0020	0000	(load R3)
13	0261	C	*this command defines the velocity as 200,000 steps/sec				
14	0004	1	0004	0000	0020	0000	(load R1)
15	0100	2	0004	0100	0020	0000	(load R2)
16	0008	3	0004	0100	0008	0000	(load R3)
17	8888	4	0004	0100	0008	8888	(load R4)
18	0200	C	*this command defines Move #4 as 88,888 steps counterclockwise				

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REGISTER CONTENTS (Continued)

Entry	BCD value	Strobe	R1	R2	R3	R4
19	0000	1	0000	0000	0008	8888 (load R1)
20	0000	4	0000	0000	0010	0000 (load R4)
21	0010	3	0000	0000	0010	0000 (load R3)
22	0262	C	*this command defines the acceleration parameter as 100,000 steps/sec/sec			
23	0015	3	0000	0000	0015	0000 (load R3)
24	0261	C	*this command defines the velocity as 150,000 steps/sec			
25	0008	1	0008	0000	0040	0000 (load R1)
26	0000	3	0008	0000	0000	0000 (load R3)
27	0203	C	*this command defines Move #8 as a move to absolute position zero			
28	0217	C	* this command begins the Sequence			
29	0001	1	0001	0000	0000	0000 (load R1)
30	0116	C	* this command will stop the motor and the Sequence on TRIGGER 1			
31	0011	1	0011	0000	0000	0000 (load R1)
32	0005	3	0011	0000	0005	0000 (load R3)
32	0032	C	*this command starts an 11 command loop which will repeat 5 times			
33	0002	1	0002	0000	0000	0000 (load R1)
34	0064	C	*this command calls for execution of Move #2			
35	0002	1	0002	0000	0000	0000 (load R1)
36	0001	2	0002	0001	0000	0000 (load R2)
37	0044	C	*this command waits until TRIGGER 2 is off (high)			
38	0004	1	0004	0002	0000	0000 (load R1)
39	0064	C	*this command calls for execution of Move #4			
40	0064	C	*this command calls for execution of Move #4 again			
41	0003	1	0003	0002	0000	0000 (load R1)
42	0001	2	0003	0001	0000	0000 (load R2)
43	0044	C	*this command waits until TRIGGER 3 is off (high)			

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REGISTER CONTENTS (Continued)

Entry	BCD value	Strobe	R1	R2	R3	R4	
44	0001	1	0001	0001	0000	0000	(load R1)
45	0011	C	*this command turns on OUT 1				
46	0002	1	0002	0001	0000	0000	(load R1)
47	0011	C	*this command turns on OUT 2				
48	0000	2	0002	0000	0000	0000	(load R2)
49	0002	3	0002	0000	0002	0000	(load R3)
50	0042	C	*this command causes a 2 second wait				
51	0012	C	*this command turns off OUT 2				
52	0001	1	0001	0000	0002	0000	(load R1)
53	0012	C	*this command turns off OUT 1				
54	0008	1	0008	0000	0002	0000	(load R1)
55	0064	C	*this command executes move #8				
56	0216	C	*this command ends the Sequence				

The sequence of characters required to implement these functions using the serial data feature is as follows:

1. 0 0 100 0 262
2. 0 0 10 0 261
3. 2 0 10 7777 200
4. 0 0 70 0 262
5. 0 0 20 0 261
6. 4 100 8 8888 200
7. 0 0 10 0 262
8. 0 0 15 0 261
9. 8 0 0 0 203
10. 8 0 0 0 217
11. 0 1 0 0 116
12. 110 5 0 32
13. 2 0 0 0 64
14. 2 1 0 0 44
15. 4 0 0 0 64
16. 4 0 0 0 64
17. 3 1 0 0 44
18. 2 0 0 0 11
19. 1 0 0 0 11
20. 0 0 2 0 42
21. 2 0 0 0 12
22. 1 0 0 0 12
23. 8 0 0 0 64
24. 0 0 0 0 216

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Appendix C

JUMPER LOCATION AND IDENTIFICATION

See page 3-7 for current 430 Switch settings.

The drawing on the next page details the location of the jumpers on the earlier 430 circuit board. To access the board, remove the left hand side cover of the unit. The function of these jumpers is listed below.

NOTE: Jumpers JU1 through JU20 and JU25 through JU64 are arranged in sets of four, each representing one BCD digit. The jumpers are assigned the values 1, 2, 4, and 8 in order. The sum of the assigned values for jumpers in the on position determines the BCD value for those four jumpers. An example is shown on the next page.

JU1-JU4:	Go Home Velocity (percent of Velocity X 10)	(1)
JU5-JU8:	Least Significant Digit - Velocity Data	(0)
JU9-JU12:	2nd Digit - Velocity Data	(0)
JU12-JU16:	3rd Digit - Velocity Data	(0)
JU17-JU2:	Most Significant Digit - Velocity Data	(1)
		(1000)

(X 250 Range yields 250,000 steps/sec = 10 rev/sec)

JU21:	Velocity Range multiplier - OFF=X25, ON=X250	(ON)
JU22:	#3 Acceleration Range Multiplier - X 100	(OFF)
JU23:	#2 Acceleration Range Multiplier - X 1,000	(ON)
JU24:	#1 Acceleration Range Multiplier - X 10,000	(OFF)

(All OFF: #4 Acceleration Range Multiplier - X 10)
(Select one)

JU25-JU28:	Least Significant Digit - Acceleration Data	(5)
JU29-JU32:	Most Significant Digit - Acceleration Data	(2)
		(25)

(Range #2 yields 25,000 steps/sec/sec)

JU33:	Go Home Direction, ON=CCW, OFF=CW	(CW)
JU34:	Home Limit Signal Edge, ON=CCW, OFF=CW	(CW)
JU35:	Home Limit Polarity, ON=high true, OFF=low true	(OFF)
JU36:	BIT 0 TO 16 Polarity, ON=high true, OFF=low true	(OFF)

JU37-JU40:	Least Significant Digit - Position Data	(0)
JU41-JU44:	2nd Digit - Position Data	(0)
JU45-JU48:	3rd Digit - Position Data	(0)
JU49-JU52:	4th Digit - Position Data	(5)
JU53-JU56:	5th Digit - Position Data	(2)
JU57-JU60:	6th Digit - Position Data	(0)
JU61-JU64:	Most Significant Digit - Position Data	(2)
		(25,000)

(25,000 steps = 1 revolution std motor)

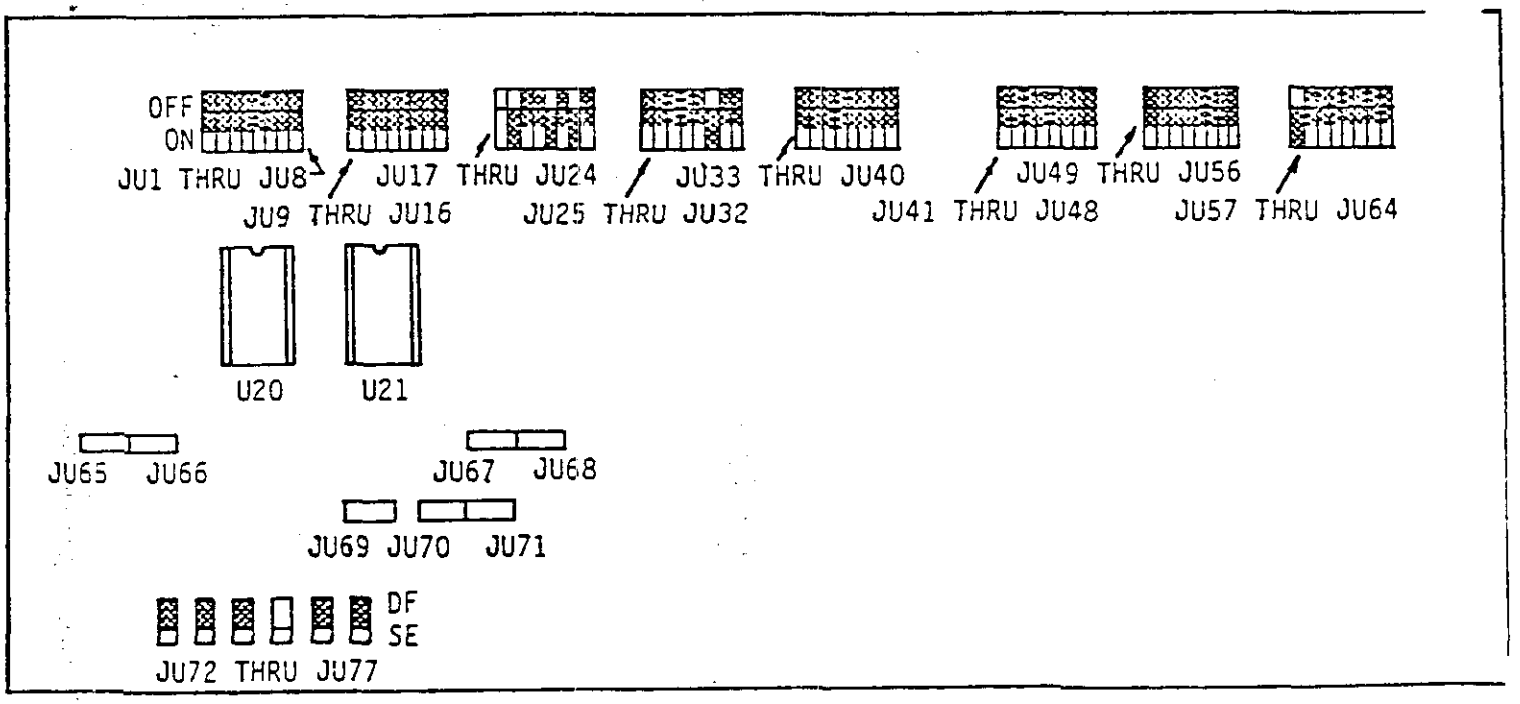
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Jumpers JU65 through JU68 are Reserved: Do Not Remove

JU69:	Encoder Direction Polarity (clockwise)	(OFF)
JU70:	Z CHANNEL Polarity, ON=high true, OFF=low true	(OFF)
JU71:	Home Limit Polarity, ON=hight true, OFF=low true	(OFF)
JU72:	SHUTDOWN Out, ON=Differential, OFF=Single ended	(OFF)
JU73:	Direction Out, ON=Differential, OFF=Single ended	(OFF)
JU74:	Step Output, ON=Differential, OFF=Single ended	(OFF)
JU75:	Reserved Out	(OFF)
JU76:	Reserved Out	(OFF)
JU77:	Reserved Out	(OFF)

Example: Jumpers JU1 through JU4 represent one BCD digit. The following table indicates how to set them to get BCD values of seven and nine.

Jumper	Value	Setting (7)	Setting (9)
JU1	1	ON	ON
JU2	2	ON	OFF
JU3	4	ON	OFF
JU4	8	OFF	ON
		1+2+4=7	1+8=9



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