

## Hardware Reference

### Chapter Objectives

---

This chapter is designed to function as a quick-reference tool for the following information:

- System specifications (dimensions and performance)
- Jumper and DIP switch settings
- I/O connections and specifications

### OEMØ23-AT System Specifications

---

Refer to the following table for OEMØ23-AT System Specifications.

<b>Performance</b>	Stepping Accuracy	±0 steps from preset total
	Velocity Accuracy	±0.02% of maximum rate above 0.01 revs/sec
	Velocity Repeatability	±0.02% of maximum rate
Velocity	25,000 steps/rev	0.01 - 20.00 rps
Range	5,000 steps/rev	0.01 - 100.00 rps
Acceleration	25,000 steps/rev	0.01 - 999.9 rps <sup>2</sup>
Range	5,000 steps/rev	0.05 - 4,999.95 rps <sup>2</sup>
	Position Range (all resolutions)	0 - 99,999,999 steps
<b>Power Input</b>	Indexer Board: +5VDC @ 1.2A typical, 1.5A maximum (from user's PC)	
<b>Interface</b>	IBM PC interface in accordance with IBM I/O channel signal specifications and definitions. Uses the following I/O channel signal lines:	
	<input type="checkbox"/> +AØ, +A2 through +A9	<input type="checkbox"/> -IOW
	<input type="checkbox"/> +D0 through +D7	<input type="checkbox"/> +IRQ3
	<input type="checkbox"/> +AEN	<input type="checkbox"/> +IRQ4
	<input type="checkbox"/> +RESET	<input type="checkbox"/> +5V
	<input type="checkbox"/> +IOR	<input type="checkbox"/> GND
<b>Inputs</b>	CW & CCW Limits, Home Enable, and Triggers      ØV - 5V TTL	
<b>Outputs (Step, Direction, Shutdown, and POBs)</b>	Single-ended outputs.	
	Signal high	+3.0VDC minimum @ +30mA
	Signal low	+1.0VDC maximum @ -30mA
	Step signal duration:	15 µs nominal @ 200 - 400 steps/rev
		1 µs nominal @ 21,600 - 50,000 steps/rev
<b>Environmental</b>	Operating Temperature	32°F to 122°F (0°C to 50°C);
	Humidity	0 to 95% (non-condensing)
	Storage	-22°F to 185°F (-30°C to 85°C)

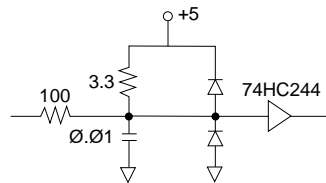
# I/O Connections

This section provides circuit drawings.

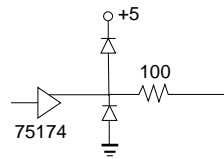
## VM50 Connector Pinouts

Pin #	Axis #	Function	Pin #	Axis #	Function
1	1	CCW Limit	26		Reserved
2	1	CW Limit	27	2	CCW Limit
3	1	Home Enable	28	2	CW Limit
4		GND	29		GND
5		TRIG 2	30		GND
6		TRIG 1	31		TRIG 4
7		POB 1	32		TRIG 3
8		POB 2	33		GND
9	1	Shutdown +	34	2	Home Enable
10	1	Shutdown -	35	3	CCW Limit
11		GND	36	3	CW Limit
12		GND	37		Reserved
13	1	Step	38		Reserved
14	1	Direction	39	3	Step
15	2	Step	40	3	Direction
16	2	Direction	41	3	Shutdown +
17		GND	42	3	Shutdown -
18		Reserved	43		POB 5-
19	2	Shutdown +	44		POB 5+
20	2	Shutdown -	45		GND
21		POB 3	46		GND
22		POB 4	47		GND
23		GND	48	3	Home Enable
24		GND	49		TRIG 5
25		Reserved	50		TRIG 6

### Auxiliary Connector: Typical Input Circuit



### Auxiliary Connector: Typical Output Circuit



## Jumper Settings

The table below identifies the function and default settings for each jumper.

Jumper	Function	Default Setting
PC Board Jumpers:		
JU13	Enable/disable self test function	Installed (disables self test)
JU27/JU28	Select interrupt 3 (JU27) or 4 (JU28) on PC I/O bus	Removed (no interrupts)
JU1 Axis 3 CCW Limit	<i>All of these jumpers must be installed when limits are used as single-ended inputs (standard set-up) with the factory cable.</i>	
JU3 Axis 3 CW Limit		
JU5 Axis 2 CCW Limit		
JU7 Axis 2 CW Limit		
JU9 Axis 1 CCW Limit		
JU11 Axis 1 CW Limit		

## Changing Outputs from Single-Ended to Differential

The OEMØ23-AT is shipped with its step and direction outputs configured as TTL-compatible, single-ended at the VM50. If differential is required, the signals may be connected by building a cable to add the required signals. Refer to the pinout for the main board.

### OEMØ23-AT Main Board Pinout (J1)

Pin #	Description	Pin #	Description
1	TFRM 1 -	18	STEP 3 +
2	RMCLK +	19	DIR 3 -
3	TFRM 1 +	20	STEP 3 -
4	RMCLK -	21	CW LIMIT 3 +
5	GND	22	CCW LIMIT 3 +
6	GND	23	CW LIMIT 3 -
7	TRIG 6	24	CCW LIMIT 3 -
8	TRIG 5	25	POB 6 +
9	HOMEN 3	26	POB 6 -
10	GND	27	
11	GND	28	+5
12	GND	29	CH A 3 +
13	POB 5 +	30	CH A 3 -
14	POB 5 -	31	CH Z 3 +
15	SHUTDOWN 3 -	32	CH B 3 -
16	SHUTDOWN 3 +	33	CH B 3 +
17	DIR 3 +	34	CH Z 3 -

### OEMØ23-AT Main Board Pinout (J2)

Pin #	Description	Pin #	Description
1	GND	18	GND
2	GND	19	CW LIMIT 2 +
3	CH A 2 +	20	CCW LIMIT 2 +
4	CH A 2 -	21	CW LIMIT 2 -
5	CH Z 2 +	22	CCW LIMIT 2 -
6	CH B 2 -	23	GND
7	CH B 2 +	24	GND
8	CH Z 2 -	25	POB 4
9	GND	26	POB 3
10	GND	27	SHUTDOWN 2 -
11	+5	28	SHUTDOWN 2 +
12	+5	29	GND
13	HOMEN 2	30	GND
14	GND	31	DIR 2 +
15	TRIG 3	32	STEP 2 +
16	TRIG 4	33	DIR 2 -
17	GND	34	STEP 2 -

### OEMØ23-AT Main Board Pinout (J3)

Pin #	Description	Pin #	Description
1	DIR 1 -	18	CCW LIMIT 1 -
2	STEP 1 -	19	+5
3	DIR 1 +	20	+5
4	STEP 1 +	21	GND
5	GND	22	GND
6	GND	23	CH A 1 +
7	SHUTDOWN 1 -	24	CH A 1 -
8	SHUTDOWN 1 +	25	CH Z 1 +
9	POB 2	26	CH B 1 -
10	POB 1	27	CH B 1 +
11	TRIG 1	28	CH Z 1 -
12	TRIG 2	29	GND
13	GND	30	GND
14	HOMEN 1	31	XMTFRM +
15	CW LIMIT 1 +	32	XMRMCLK +
16	CCW LIMIT 1 +	33	XMTFRM -
17	CW LIMIT 1 -	34	XMRMCLK -

## DIP Switch Settings: (Indexer Card Address 35)

The address is set using the 8-position DIP switch located on the OEMØ23-AT indexer card. The DIP switches are *negative true* in that any switch in the position marked ON has a binary value of zero. Switches that are OFF have a non-zero binary value. The sum of the binary values of DIP switches 1 through 8 is the board's *base address*. The binary values assigned to each of the eight DIP switches are listed below.

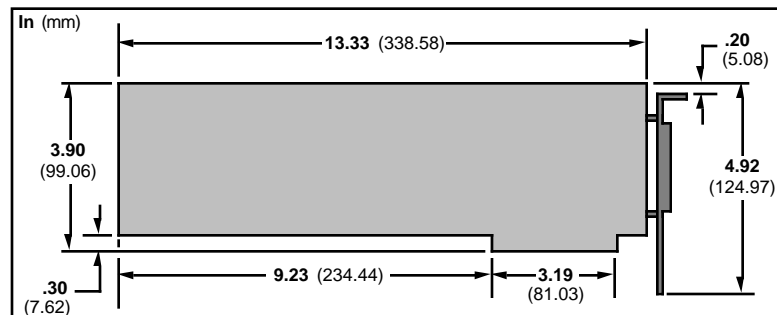
Switch #	Address	Binary Value (OFF)		Default Setting
		Decimal	Hex	
1	9	512	200	OFF
2	8	256	100	OFF
3	7	128	80	ON
4	6	64	40	ON
5	5	32	20	ON
6	4	16	10	ON
7	3	8	8	ON
8	2	4	4	ON

The OEMØ23-AT is shipped from the factory with switches 1 and 2 in the OFF position, all others are ON. The board address is  $256 + 512 = 768$  (or  $100 + 200 = 300$  hex). The OEMØ23-AT is configured to occupy I/O address locations 300 hex - 303 hex. The control and status registers are at the odd address location (301 hex), and data registers are at the even address location (30Ø hex). Allowable address locations are highlighted below.

Hex Range	Device	Hex Range	Device
ØØØ-Ø1F	DMA Controller 1, 8237A-5	36C-36F	Reserved
Ø2Ø-Ø3F	Interrupt controller 1, 8259A, Master	378-37F	Parallel printer port 1
Ø4Ø-Ø5F	Timer, 8254-2	38Ø-38F	SDLC, bisynchronous 2
Ø6Ø-Ø6F	8Ø42 (Keyboard)	39Ø-393	Cluster
Ø7Ø-Ø7F	Real-time clock, NMI (non-maskable interrupt) mask	3AØ-3AF	Bisynchronous 1
Ø8Ø-Ø9F	DMA page register, 74LS612	3BØ-3BF	Monochrome Display and Printer Adapter
ØAØ-ØBF	Interrupt Controller 2, 8259A	3CØ-3CF	Enhanced Graphics Adapter
ØCØ-ØDF	DMA controller 2, 8237A-5	3DØ-3DF	Color/Graphics Monitor Adapter
ØFØ	Clear Math Co-processor Busy	3FØ-3F7	Diskette Controller
ØF1	Reset Math Co-processor	3F8-3FF	Serial port 1
ØF8-ØFF	Math Co-processor	6E2 & 6E3	Data acquisition (Adapter 1)
1FØ-1F8	Fixed Disk	79Ø-793	Cluster (Adapter 1)
2ØØ-2Ø7	Game I/O	AE2 & AE3	Data acquisition (Adapter 2)
2ØC-2ØD	Reserved	B9Ø-B93	Cluster (Adapter 2)
21F	Reserved	EE2 & EE3	Data acquisition (Adapter 3)
278-27F	Parallel printer port 2	139Ø-1393	Cluster (Adapter 3)
2BØ-2DF	Alternate Enhanced Graphics Adapter	22E1	GPIB (Adapter 1)
2E1	GPIB (Adapter Ø)	239Ø-2393	Cluster (Adapter 4)
2E2 & 2E3	Data Acquisition (Adapter 3)	42E1	GPIB (Adapter 2)
2F8-2FF	Serial Port 2	62E1	GPIB (Adapter 3)
3ØØ-31F	<i>Prototype Card</i>	82E1	GPIB (Adapter 4)
36Ø-363	PC Network (low address)	A2E1	GPIB (Adapter 5)
364-367	Reserved	C2E1	GPIB (Adapter 6)
368-36B	PC Network (high address)	E2E1	GPIB (Adapter 7)

I/O Address, hex ØØØ to ØFF, are reserved for the system board I/O. Hex 1ØØ to 3FF are available on the I/O channel.

## ØEM23-AT Dimensions



# C H A P T E R ⑥

## Troubleshooting

### Chapter Objective

The information in this chapter is provided to help you to isolate and resolve system hardware and software problems.

### Spare Parts List

Description	Part Number
Phillips screws 4-40 x 1/4	51-006021-01
Phillips screws 6-32 x 1/4	51-006037-01

### Troubleshooting

This section discusses methods to identify, isolate, and resolve indexer-related problems that may occur with your OEMØ23-AT Indexer.

### Isolating Problems

When your system does not function properly (or as you expect it to operate), the first thing to do is identify and isolate the problem.

Determine if the problem is mechanical, electrical, or software related. *Can you repeat or re-create the problem?* Do not make quick rationalizations about problems. Random events may appear to be related, but they are not necessarily contributing factors to your problem. Carefully investigate and decipher the events that occur before the subsequent system problem.

More than one problem may exist. Solve one problem at a time. Log (document) all testing and problem isolation procedures. Review and consult these notes. This will prevent duplication of testing efforts.

Isolate each system component and ensure that each component functions properly when it is run independently. Try removing system components and re-installing them component-by-component to detect the problem. If you have additional components available, use them to replace existing components in your system to identify the source of the problem.

#### **WARNING**

Remove power before disconnecting system components or changing wiring.

Once the problem isolated, take the necessary steps to resolve it (refer to the problem solutions below). If the problem persists, contact Parker Compumotor's Applications Department at (800) 358-9070.

## Problems & Solutions

Problem	Cause	Solution
No Communication	<ol style="list-style-type: none"> <li>① Wrong Address</li> <li>② Two boards have same address</li> <li>③ Board not seated</li> </ol>	<ol style="list-style-type: none"> <li>① Change jumpers or software address</li> <li>② Change address on one board (unique addresses)</li> <li>③ Seat board in IBM Bus</li> </ol>
No Motion	<ol style="list-style-type: none"> <li>① Step pulse width too narrow for drive to recognize</li> <li>② Limits engaged</li> <li>③ Improper Wiring: Drive Faults Shutdown line miswired</li> <li>④ Load is jammed</li> </ol>	<ol style="list-style-type: none"> <li>① Issue <b>MR</b> command to set motor resolution.</li> <li>② Issue <b>LD3</b> or move load off of limit.</li> <li>③ Check wiring, be sure the self-test jumper (JU13) is not removed. Refer to <i>Chapter 5 Hardware Reference</i>.</li> <li>④ Remove power and manually move load away from jam.</li> </ol>
No Torque	<ol style="list-style-type: none"> <li>① Improper wiring</li> <li>② Blown drive</li> <li>③ Drive faulted</li> <li>④ Drive Shutdown</li> </ol>	<ol style="list-style-type: none"> <li>① Check wiring. Refer to <i>Chapter 5 Hardware Reference</i>.</li> <li>② Return drive for repair.</li> <li>③ Remove fault condition.</li> <li>④ Issue the <b>ST0</b> command to energize the drive.</li> </ol>
Fault Light Comes On	<ol style="list-style-type: none"> <li>① Jumper JU13 removed</li> <li>② Hardware failure</li> </ol>	<ol style="list-style-type: none"> <li>① Ensure the self-test jumper JU13 is not removed.</li> <li>② Return unit for repair.</li> </ol>
Wrong Speed or Distance	<ol style="list-style-type: none"> <li>① Wrong resolution setting</li> </ol>	<ol style="list-style-type: none"> <li>① Issue <b>MR</b> command to set motor resolution.</li> </ol>
Motor Creeps	<ol style="list-style-type: none"> <li>① Jumper JU13 removed</li> </ol>	<ol style="list-style-type: none"> <li>① Install self-test jumper (JU13).</li> </ol>
No POB Operation	<ol style="list-style-type: none"> <li>① Improper wiring</li> <li>② Shorted POB</li> <li>③ No power to pull-up</li> </ol>	<ol style="list-style-type: none"> <li>① Check wiring. Refer to <i>Chapter 5 Hardware Reference</i>.</li> <li>② Check for shorts on open collector POB outputs.</li> <li>③ Connect external 5VDC to pin 23 and GND to pin 21 on any <b>AUXILIARY</b> connector.</li> </ol>
No Trigger Inputs	<ol style="list-style-type: none"> <li>① Improper wiring</li> </ol>	<ol style="list-style-type: none"> <li>① Check wiring. Refer to <i>Chapter 5 Hardware Reference</i>.</li> </ol>

## Reducing Electrical Noise

### Helpful Hint:

For more on identifying and suppressing electrical noise, refer to the *Compumotor Programmable Motion Control Catalog*.

If you operate the OEM023-AT in an environment in which there is an excessive amount of electrical noise, try to eliminate sources of possible noise interference. Potential sources of electrical noise include inductive devices such as solenoids, relays, motors, and motor starters when they are operated by a hard contact.

## Returning The System

### Helpful Hint:

Use the following steps, to return the OEM023-AT for repairs or upgrades.

- ① Get the serial number and the model number of the defective unit, and a purchase order number to cover repair costs in the event the unit is determined by Parker Compumotor to be out of warranty.
- ② Before you ship the indexer to Parker Compumotor, have someone from your organization with a technical understanding of the OEM023-AT Indexer and its application include answers to the following questions:
  - What is the extent of the failure/reason for return?
  - How long did it operate?
  - How many units are still working?
  - How many units failed?
  - What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc.)?
  - How was the product configured (in detail)?
  - What, if any, cables were modified and how?
  - With what equipment is the unit interfaced?
  - What was the application?
  - What was the system sizing (speed, acceleration, duty cycle, inertia, torque, friction, etc.)?
  - What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
  - What upgrades, if any, are required (hardware, software, user guide)?
- ③ Call Parker Compumotor for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number. The phone number for Parker Compumotor Applications Department is (800) 358-9070.
- ④ Ship the unit to:

Parker Compumotor Corporation  
5500 Business Park Drive, Suite D  
Rohnert Park, CA 94928  
Attn.: RMA # xxxxxxxx

# A P P E N D I C E S

---

## Command Listing

<b>A</b>	(ACCELERATION)	<b>QIB</b>	(INTERRUPT STATUS REPORT, BINARY)
<b>B</b>	(BUFFER STATUS)	<b>QR</b>	(REPORT QS COMMAND FUNCTION ENABLE STATUS)
<b>C</b>	(CONTINUE)	<b>QS</b>	(INTERRUPT ON SIGNAL COMMANDS)
<b>CR</b>	(CARRIAGE RETURN)	<b>QSA</b>	(INTERRUPT ON TRIGGER #1 HIGH)
<b>D</b>	(DISTANCE)	<b>QSB</b>	(INTERRUPT ON MOVE COMPLETE)
<b>FR</b>	(ENCODER FUNCTIONS REPORT)	<b>QSD</b>	(INTERRUPT SIGNAL ON LIMIT ENCOUNTERED)
<b>FSA</b>	(SET INCREMENTAL/ABSOLUTE MODE)	<b>QSE</b>	(INTERRUPT ON READY TO RESPOND)
<b>FSF</b>	(ENABLE STOP ON TRIGGER #6)	<b>QSG</b>	(INTERRUPT ON COMMAND BUFFER FULL)
<b>G</b>	(GO)	<b>QSH</b>	(INTERRUPT ON MOTOR STALL)
<b>GNNN</b>	(SYNCHRONIZED GO)	<b>R</b>	(REQUEST INDEXER STATUS)
<b>GA</b>	(GO HOME ACCELERATION)	<b>RA</b>	(LIMIT SWITCH STATUS REPORT)
<b>GH</b>	(GO HOME)	<b>RB</b>	(REPORT LOOP, PAUSE, SHUTDOWN, TRIGGER STATUS)
<b>^H</b>	(BACKSPACE)	<b>RC</b>	(REPORT CLOSED LOOP AND GO HOME STATUS)
<b>H</b>	(SET DIRECTION)	<b>RM</b>	(RATE MULTIPLIER IN IMMEDIATE VELOCITY STREAMING MODE)
<b>I</b>	(LOAD MOVE DATA)	<b>RV</b>	(REPORT SOFTWARE PART NUMBER)
<b>IO</b>	(IMMEDIATE OUTPUT)	<b>S</b>	(STOP)
<b>IS</b>	(INPUT STATUS )	<b>SA</b>	(STOP ALL)
<b>K</b>	(KILL)	<b>SD</b>	(DEFINE TIMED DATA STREAMING MODE STREAMING DATA)
<b>L</b>	(LOOP)	<b>SR</b>	(REPORT CONFIGURATION STATUS)
<b>LA</b>	(LIMIT ACCELERATION)	<b>SSD</b>	(MODE ALTERNATE STOP MODE)
<b>LD</b>	(LIMIT DISABLE)	<b>SSF</b>	(NORMAL/LOW VELOCITY RANGE)
<b>MA</b>	(MODE ALTERNATE)	<b>SSG</b>	(CLEAR/SAVE THE COMMAND BUFFER ON LIMIT)
<b>MC</b>	(MODE CONTINUOUS)	<b>SSH</b>	(CLEAR/SAVE THE COMMAND BUFFER ON STOP)
<b>MN</b>	(MODE NORMAL)	<b>ST</b>	(SHUTDOWN)
<b>MPA</b>	(MODE POSITION ABSOLUTE)	<b>T</b>	(TIME DELAY)
<b>MPI</b>	(MODE POSITION INCREMENTAL)	<b>TD</b>	(SET TIME INTERVAL FOR TIMED DATA STREAMING MODE)
<b>MR</b>	(SELECT MOTOR RESOLUTION)	<b>TR</b>	(WAIT FOR TRIGGER)
<b>MSL</b>	(IDENTIFY CLOCK SOURCE FOR TIMED DATA STREAMING)	<b>TS</b>	(REPORT TRIGGER STATUS)
<b>MSS</b>	(START MASTER CLOCK FOR TIMED DATA STREAMING)	<b>U</b>	(PAUSE AND WAIT FOR CONTINUE)
<b>N</b>	(END OF LOOP)	<b>UR</b>	(REPORT SCALE FACTOR STATUS)
<b>O</b>	(OUTPUT)	<b>US</b>	(SET POSITION SCALE FACTOR)
<b>OR</b>	(REPORT FUNCTION SETUPS)	<b>V</b>	(VELOCITY)
<b>OSA</b>	(SET ENCODER DIRECTION)	<b>W1</b>	(SIGNED BINARY POSITION REPORT)
<b>OSB</b>	(BACKUP TO HOME)	<b>W3</b>	(HEXADECIMAL POSITION REPORT)
<b>OSC</b>	(DEFINE ACTIVE STATE OF HOME SWITCH)	<b>Y</b>	(STOP LOOP)
<b>OSD</b>	(DEFINE ACTIVE STATE OF ENCODER'S Z CHANNEL INPUT)		
<b>OSG</b>	(SET FINAL GO HOME DIRECTION)		
<b>OSH</b>	(REFERENCE EDGE OF HOME SWITCH)		
<b>P</b>	(REPORT INCREMENTAL POSITION, ASCII)		
<b>PB</b>	(REPORT INCREMENTAL POSITION, BINARY)		
<b>PR</b>	(REPORT ABSOLUTE POSITION)		
<b>PS</b>	(PAUSE)		
<b>PZ</b>	(POSITION ZERO)		
<b>Q</b>	(COMPLETE CURRENT COMMAND AND CLEAR COMMAND BUFFER)		
<b>QØ</b>	(EXIT STREAMING MODE)		
<b>Q1</b>	(ENTER IMMEDIATE VELOCITY STREAMING MODE)		
<b>Q2</b>	(ENTER TIME-DISTANCE STREAMING MODE)		
<b>Q3</b>	(ENTER TIME-VELOCITY STREAMING MODE)		
<b>QI</b>	(REPORT STATUS OF QS COMMANDS)		





# I N D E X

## A

ABSOLUTE MODE 18  
ABSOLUTE ZERO POSITION 18  
ACCELERATION RANGE 41  
ACCURACY 16  
ADDRESS 4  
    CONTROL AND STATUS REGISTERS 4  
    DATA REGISTERS 4  
    DIP SWITCH 4  
ADDRESS SETTINGS 4  
ALTERNATING MODE 18  
ASSEMBLY ROUTINES 33  
AUXILIARY CONNECTIONS 10  
AXIS-SPECIFIC PREFIX 15

## B

BACKLASH 13  
BASE ADDRESS 4, 44  
BASIC PROGRAM 35  
BENCH TEST  
    TOOLS 3  
BENCH TEST CONFIGURATION 3  
BINARY INPUT MODE 30  
BUFFER PAUSE 26

## C

C PROGRAM 36  
C SUPPORT ROUTINE 33  
CARD GUIDE 5  
CARTESIAN COORDINATES 37  
CLOCK SOURCE 24  
COMMAND LISTING 47  
COMMAND STRINGS 34  
CONTINUE (C) COMMAND 11  
CONTINUOUS DATA STREAMING 29  
CONTINUOUS MODE 19  
CONTROL BYTE 31  
CONTROL BYTE FLAGS 31  
CUSTOM PROFILES 21

## D

DEMONSTRATION DISKETTES 31  
DIP SWITCHES 4, 44  
DISCRETE DATA STREAMING 29  
DRIVE FAULT 32

## E

ELECTRICAL NOISE 10, 46  
ELECTRO-STATIC DISCHARGE (ESD) 5  
END-OF-TRAVEL LIMIT INPUTS 10  
ENDLOOP COMMANDS 25  
EXTERNAL CLOCK 24

## G

GO HOME (GH) COMMAND 13  
GO HOME STATUS (RC) COMMAND 13

## H

HOME ENABLE INPUT 10  
HOME REFERENCE POSITION 10  
HOMING FUNCTION 13  
HOMING FUNCTION TEST 13  
HUMIDITY 41  
HYSTERESIS 16

## I

INCREMENTAL MODE 17  
INDEXER 1  
    FEATURES 1  
    FUNCTIONS 1  
INPUT DATA BUFFER (IDB) 31  
INPUTS 10  
INSTALLATION PRECAUTIONS 9  
INTERRUPT ACKNOWLEDGE BIT 39  
INTERRUPT CONTROLLER CHIP 38  
INTERRUPT OUTPUT 39  
INTERRUPT REQUEST LINES 38

## J

JUMPERS 42

## L

LANGUAGE CONSIDERATIONS 30  
LOOP 20  
LOOP COMMANDS 25

## M

MASK 34  
MASTER CLOCK 37  
MOTOR RESOLUTION 19  
MOUNTING BRACKET 5  
MULTI-AXIS SIMULATION 15  
MULTIPLE OEMØ23-ATs 37

## N

NORMAL MODE 17

## O

ON-THE-FLY 23  
OPEN-LOOP ABSOLUTE ACCURACY 16  
OUTPUT DATA BUFFER (ODB) 31  
OVERSHOOT 14, 16

**P**

PASCAL PROGRAM 36  
 PASCAL SUPPORT ROUTINE 33  
 PCA CARD 5  
 PCA CARD GUIDE 5  
 POB DATA POINTS 26  
 POBs 20, 26  
 POLAR COORDINATES 38  
 POSITION REPORT 18  
 POSITION ZERO (PZ) COMMAND 18  
 POSITIONING MODES 17  
   ABSOLUTE PRESET 18  
   ALTERNATING MODE 18  
   CONTINUOUS MODE 18  
   INCREMENTAL 17  
   NORMAL 17  
 POWER INPUT 41  
 PROGRAM CONTROL FEATURES 20  
 PROGRAM EXAMPLES 35  
 PROGRAMMABLE OUTPUT BITS 10, 13  
 PROGRAMMING 30, 33  
 PYTHAGOREAN THEOREM 37

**Q**

QUICK BASIC SUPPORT ROUTINE 33

**R**

READING CHARACTERS 35  
 RECEIVING A CHARACTER 32  
 REGISTER 31  
 RELATED PUBLICATIONS IV  
 REPAIRS 46  
 REPEATABILITY 16, 19  
 RESETTING THE OEMØ23-AT 35  
 RESONANCE 15  
 RESPONSE STRINGS 34  
 RETURN MATERIAL AUTHORIZATION (RMA) NUMBER 46  
 RETURNING THE SYSTEM 46  
 RINGING 16

**S**

SELF TEST FUNCTION 4  
   JUMPER JU13 4  
 SENDING A CHARACTER 32  
 SETTLING TIME 16  
 SHIP KIT 3  
 SINGLE-AXIS OPERATION 15  
 SPECIAL DATA POINTS 24  
 SPECIFICATIONS 41  
 STATUS BYTE 31, 34  
 STATUS BYTE FLAGS 32  
 STEPPING ACCURACY 41  
 STREAMING DATA 24  
 SUPPORT DISK 33  
   ASSEMBLY ROUTINES 33  
 SUPPORT DISK FILE STRUCTURES 33  
 SYSTEM TEST 7

**T**

TEMPERATURE 41  
 TERMINAL EMULATION 11, 17  
 TIME-DISTANCE STREAMING MODE 23, 27  
 TIME-VELOCITY STREAMING MODE 23  
 TIMED DATA STREAMING MODE 27  
   RESTRICTIONS 27  
 TRIGGER INPUTS 10, 11  
 TRIGGERS 26  
 TROUBLESHOOTING 45

**U**

UNI-DIRECTIONAL REPEATABILITY 16  
 UPDATE INTERVAL 23  
 UTILITY COMMANDS 11

**V**

VELOCITY ACCURACY 41  
 VELOCITY RANGE 41  
 VELOCITY REPEATABILITY 41  
 VELOCITY STREAMING MODES 21  
   IMMEDIATE VELOCITY STREAMING 21  
   TIME-VELOCITY STREAMING MODE 28  
   TIMED DATA STREAMING 23  
 VM50 5, 7  
   CONNECTOR PIN ASSIGNMENTS 10

**W**

WATCHDOG TIMER 32  
 WRITING CHARACTERS 35

**X**

X LANGUAGE COMMANDS 17, 31  
 X-Y POSITIONING SYSTEM 37