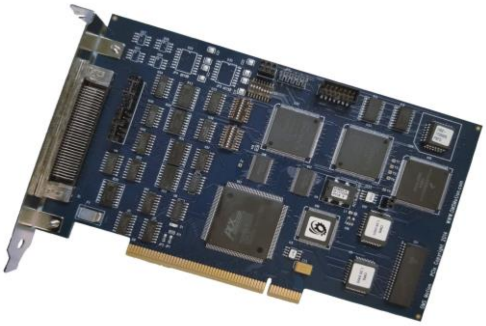
OMS
MOTION, Inc.



PCIx

Intelligent Motion Controller for PCI

FEATURES

- **Controller capabilities**
  → Two or Four axes of Servo, Stepper or Servo and Stepper control
  → Half Size PCI Short Card Dimensions
  → Single high density shielded SCSI connector
  → PCI Rev. 2.2 Compliant

- **Communication Interface**
  → PCI 33 MHz Target Device
  → 4 I/O registers for control & status
  → Requires only one PCI Slot

- **Sophisticated Control Functionality**
  → 16 bit DAC analog resolution
  → Independent and coordinated motion of all axes simultaneously
  → Slip & Stall detection with encoder feedback
  → Crystal controlled step pulse from 0 to 1,044,000 steps per second
  → Configurable PID filter with feedforward coefficients
  → Circular Interpolation
  → Constant velocity linear interpolation (all axes)
  → Electronic Gearing

- **32 bit processor for extensive co-processing**
  → Does not burden the host with overhead
  → Custom, Parabolic, “S”-curve & Linear trajectory profiles
  → Patented technology to minimized torque ripple and velocity modulation
  → Internal Watchdog timer for safety

- **Control signals**
  → Control signals are opto-isolated for noise immunity
  → Opto-isolated I/O
  → All control signals on the shielded SCSI connector
  → Motion Output is Servo (+/-10V or 0-10V) or Step & Direction
  → Independent home, positive and negative over-travel inputs

- **Software programming**
  → High level programming expertise not required
  → Over 150 commands, “universal” to other OMS controllers
  → Commands are ASCII characters
  → Automatic conversion to “user” defined units i.e. inches / revolutions
  → Software for Win NT or Win 95 at no additional cost

- **Flash Memory**
  → Field upgradable firmware
  → Removal of the board for upgrade not required
  → Non-volatile program storage

- **Factory Direct Technical Support**
  → Person to person toll-free tech support, call 800-707-8111
  → Example programs and application code provided
  → Firmware upgrades and enhancements can be implemented in the field
  → Customizable solutions available for your requirements
  → All OMS controls are 100% burned-in, tested and quality inspected

ISO 9001
CERTIFIED

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DESCRIPTION

The PCIx is a PCI^{tm} motion controller that conforms to the PCI Rev. 2.2 specification. The PCIx is up to a four-axis controller for either servo or stepping motors. It supports 12 general purpose bits which are opto-isolated for optimum noise immunity. The home and overtravel inputs are opto-isolated. The architecture of the PCIx includes a dual-port Ram for special functions where fast collection of large amounts of data is required, such as profile capture.

The servo output is a +/- 10V or 0-10V signal that is driven by a 16 bit DAC. The servo control loop is a PID filter with feedforward coefficients. The step pulse is a TTL level 50% duty cycle square wave that supports velocities of 0 through 1,044,000 pulses per second. The encoder feedback functionality supports quadrature encoders up to 4 MHz at a 4 times resolution and is used as the servo feedback, as feedback for the stepper axes or as independent position feedback. The encoder feedback can provide slip or stall detection. Every axis includes dedicated +/- overtravel inputs, a home input, and an auxiliary output. The PCIx is available in several different models at several different prices so that you don’t have to pay for a lot of functionality that you don’t need.

PROGRAMMING

PCIx motion controllers are easily programmed with ASCII character commands through an extensive command structure. The commands are combined into character strings to create sophisticated motion profiles and are passed to the PCIx data I/O register. A separate FIFO command queue for each axis is used to store the parsed commands by the PCIx until they are executed allowing the host to send a complex command sequence and attend to other tasks while the PCIx manages the motion process. These command queues store 800 command and parameter words and include a command loop counter which allows multiple executions of any command string.

The following commands are available in the PCIx family of motion controllers. All commands are sent to the controller as ASCII character strings. Some commands expect one or more numerical operands to follow. These commands are identified with a ‘#’ after the command. The ‘#’ indicates a signed integer input parameter or a signed fixed point number of the format ##.# when user units are enabled. With user units defined, distances, velocity and acceleration parameters may be input in inches, revolutions, etc.

Synchronized moves may be made by entering the AA or AM command. This command performs a context switch which allows entering commands of the format MRx#,y#,z#,t#;. Numbers are entered for each axis which is to be commanded to move. An axis may be skipped by entering the comma with no parameter. The command may be prematurely terminated with a “;”, i.e. a move requiring only the X and Y axes would use the command MRx#,y#; followed by the GO command. Each axis programmed to move will start together upon executing the GO command. The PCIx can be switched back to the unsynchronized mode by entering the desired axis command such as AX.

COMMAND SUMMARY

AXIS SPECIFIC COMMANDS:

AA AXIS ALL

Commands following the AA are directed to all axis queues for synchronized mode.

AM AXIS MULTITASKING

Commands following the AM will go into the specified axis queues for independent synchronized mode.

AX AXIS X

Commands following AX are directed to the X axis queue.

AY AXIS Y

The AY command directs all the following commands to the Y axis.

AZ AXIS Z

The AZ command directs all the following commands to the Z axis.

AT AXIS T

The AT command directs all the following commands to the T axis.

SYSTEM CONTROL COMMANDS

These commands allow control of various system parameters and operating modes to allow the user to optimize the response of the system for his/her application needs.

EN ECHO ON

The EN command enables echoing from the PCIx.

EF ECHO OFF

The EF command disables echoing from the PCIx.

HH HOME HIGH

The HH command sets the sense of the home switch on the current axis to active high.

HL HOME LOW

The HL command sets the sense of the home switch on the current axis to active low.

LH LIMIT HIGH

The LH command sets the logic sense of the overtravel limit inputs to active high.

LL LIMIT LOW

The LL command sets the logic sense of the overtravel limit inputs to active low.

LF LIMITS OFF

The LF command turns off the limit switches for the addressed axis. This allows the stage to move beyond the limit switch and should be used with caution.

LN LIMITS ON

The LN command restores the operation of the limit switches for the addressed axis.

SL SOFT LIMIT
The SL command changes the operation of the limit inputs causing the output pulse train to ramp down instead of terminating immediately. The output queue is not flushed except for the current move.

SF SOFT LIMIT OFF
The SF command restores the normal operation of the limit switches.

CN COSINE ON
The CN command enables cosine velocity ramps i.e. half sinusoid acceleration profiles for all axes.

PN# PARABOLIC ON
The PN command enables parabolic ramps. The parameter selects the point of truncation.

PF PARABOLIC OFF
The PF command restores linear acceleration and deceleration ramps.

BI BIPOLAR
The BI command sets the analog torque outputs to bipolar.

UN UNIPOLAR
The UN command sets the analog torque outputs to unipolar.

RS RESET
The RS command is a software reset which causes the PCIx microprocessor to reset. All programmable values are set to factory defaults.

MOVE SPECIFICATION COMMANDS

These commands allow specification of move parameters. They allow move parameters to be tailored to the user's system requirements.

AC# ACCELERATION
The AC command sets the acceleration/deceleration value. This value is used to establish the rate of acceleration and deceleration when a move command is invoked.

VL# VELOCITY
The VL command sets the maximum velocity value of the axis being programmed. The value is used to establish the maximum velocity when one of the move execution commands is invoked.

VB# VELOCITY BASE
The VB command allows the velocity ramp to start at the specified velocity. This allows faster acceleration and the ability to pass through resonance quickly in some applications.

LP# LOAD POSITION
The LP command will immediately load the position supplied as a parameter into the absolute position register of the axis.

MA# MOVE ABSOLUTE
The MA command will set up the axis to move to the absolute position supplied as a parameter.

MR# MOVE RELATIVE
The MR command will set up the axis to move relative from the current position at the time the move is executed.

MT#,# MOVE TO
The MT command uses linear interpolation to perform a straight line move to the specified absolute position. Up to four axes may be moved together in the AA or AM modes.

ML#,# MOVE LINEAR
The ML command uses linear interpolation to perform a straight line relative move to the new location. Up to four axes may be moved together in the AA or AM modes.

RM# REMAINDER (MODULO)
The RM command will divide the position counter by the parameter supplied and replace both the position counter and the encoder position register with the resulting remainder. This command is useful in continuously rotating axis applications.

MOVE EXECUTION COMMANDS

These commands allow execution of the moves which have been previously specified.

GO Go
The GO command will initiate the move which has been previously programmed with such commands as MA, MR, MT, and ML.

GD GO AND RESET DONE FLAG
The GD command resets the done flags on the active axes then proceeds with the move identical to the GO command.

JG# JOG
The JG command is a velocity command and will jog the axis at the velocity supplied as a parameter. The velocity may be changed without stopping by entering another JG command.

JF# JOG FRACTIONAL VELOCITIES
The JF command will jog the current axis at fractional rates for applications requiring very slow velocities.

FL FLUSH QUEUE
The FL command will immediately flush the command queue. If the stage is moving it continues to move at the current velocity.

MOVE TERMINATION COMMANDS

The following commands allow termination of move sequences in process.

ST STOP
The ST command flushes the queue for the currently addressed axis only and causes the axis to decelerate to a stop at the rate previously specified in an AC command.

SA STOP ALL
The SA command flushes all queues and causes all axes to decelerate to a stop at the rate previously specified in an AC command.

SD STOP AND RESET DONE
The SD command will stop all axes and clear any done flags.

KL KILL
The KL command will flush the command queue and terminate pulse generation of all axes immediately.

LOOP CONTROL COMMANDS

These commands allow move sequences to be repeated within loops. Loops can be nested up to four levels deep on each axis.

LS# LOOP START
The LS command sets the loop counter for the axis being programmed. The parameter specifies the number of times the loop will be executed. Loops may be nested up to 4 levels deep.

LE LOOP END
The LE command terminates the most recent LS command.

The following commands can be used to synchronize multiple PCIx boards or synchronize them to external events.

WS# WHILE SYNC TRUE
The WS command will execute the commands between the WS and WD commands as a loop, while the general purpose input line is true, i.e. low. The test is at the bottom of the loop and thus will always be executed at least once.

WD WHILE END
The WD command serves as the loop terminator for the WS command.

WH WHILE
The WH command will execute all commands until the terminating WG command as a loop, until terminated by a CW command. This allows indefinite loops to be terminated by the host computer.

WG WHILE FLAG END
The WG command serves as the terminator for the WH command.

CW CLEAR WHILE
The CW command terminates the WH command sequence upon execution of the next WG instruction. This loop is always executed at least once.

HOME AND INITIALIZATION CONTROL COMMANDS

These commands allow the coordination of the physical stage home position with the PCIx position register.

HM# HOME
The HM command will find home and initialize the position counter to the position supplied as a parameter.

HR# HOME REVERSE
The HR command will find home in the reverse direction and initialize the position counter to the position supplied as a parameter.

KM HOME AND KILL
The KM command will find home and stop generating pulses immediately, i.e. no deceleration ramp will be generated. The position counter is not affected.

KR HOME REVERSE AND KILL
The KR command will find home in reverse and stop generating pulses immediately, i.e. no deceleration ramp will be generated. The position counter is not affected.

MOVE SYNCHRONIZATION COMMANDS

These commands allow the synchronization of moves with external events or multiple axis sequences.

ID INTERRUPT DONE
The ID command will return the done flag to the host and interrupt the host if the interrupt has been enabled.

II INTERRUPT INDEPENDENT
The II command allows each axis to interrupt the host when it completes its move independent of the status of the other axes.

IN# INTERRUPT NEARLY DONE
The IN command will interrupt the host when the move is nearly complete. The parameter specifies the number of counts left in the move when the interrupt request is generated.

IC INTERRUPT CLEAR
The IC command will clear the done and error flags.

CA CLEAR AXIS DONE FLAG
The CA command operates like the IC command, except it clears the done flag of the addressed axis only.

WA WAIT FOR AXES
The WA command, only valid in the AA mode, allows a command to wait until all moves on all axes are finished before it executes.

WQ WAIT FOR QUEUE TO EMPTY
The WQ command is a special command that stops the board from processing any new command until the queue for the current axis mode is empty.

SW# SYNC WAIT
The SW command can be used to synchronize to external events by commanding the PCIx to wait for the input line to go false.

WT# WAIT TIME
The WT command will wait for the specified number of milliseconds before proceeding with the next command.

SYSTEM STATUS REQUEST COMMANDS

These commands allow the host to request the status of various move parameters, including the status of limit and home switches.

WY WHO ARE YOU
The WY command returns the model and firmware revision of the board or system being addressed.

RP RETURN POSITION
The RP command requests the current position.

RQ RETURN QUEUE STATUS
The RQ command returns the number of entries available in the command queue.

RA RETURN AXIS INTERRUPT STATUS
The RA command returns the state of the limit and home switches, and the done and direction flags for the currently addressed axis. The done flag is reset.

RI RETURN INTERRUPT STATUS
The RI command returns the state of the limit and home switches, and the done and direction flags for all axes. The done flags are reset.

QA QUERY AXIS
The QA command returns the status of the single addressed axis like the RA command, except the status register and flags are not affected.

QI QUERY INTERRUPT STATUS
The QI command returns the status of all axes like the RI command, except the status register and flags are not affected.

RC REQUEST ACCELERATION
The RC command will return the current programmed acceleration or deceleration of the current axis.

RV REQUEST VELOCITY
The RV command will return the current velocity at which the axis is moving.

RU REPORT POSITION IN USER UNITS
The RU command returns the current position in user units.

USER UNIT COMMANDS

The following commands allow specification of move parameters in user defined units. The OMS controls will automatically convert all move parameters to these units once they have been initialized.

UU# USER UNITS
The UU command converts all move velocities, distances, etc. to user specified units by multiplying by the parameter given in this command.

UF USER UNITS OFF
The UF command turns off user units and causes the PCIx board to use its default units.

USER I/O COMMANDS

The following commands allow manipulation and testing of the user definable I/O.

AN AUXILIARY ON
The AN command sets the auxiliary output to the high level. The open collector driver is off allowing the output to be pulled high by a pull-up resistor. It may be used to change power level on driver modules so equipped or as a user specified output.

AF AUXILIARY OFF
The AF command sets the auxiliary output to the low level. The open collector driver is on causing the line to be near ground. It may be used to change power level on driver modules so equipped or as a user specified output.

PA# POWER AUTOMATIC
The PA command will perform an AN command at the beginning of each move and an AF command after the move. See AN and AF commands.

SE# SETTLING TIME
The SE command allows specification of a settling time, in milliseconds, to be used before the power is reduced, when using the PA mode.

BL# BIT LOW
The BL command sets the selected general purpose output on, i.e. logic low.

BH# BIT HIGH
The BH command sets the selected general purpose output off, i.e. logic high.

BX BIT REQUEST IN HEX
The BX command returns the state of the general purpose I/O bits in hex format.

CONSTANT VELOCITY CONTOURING COMMANDS

The contouring command set allows the building of a command sequence which can later be executed at constant velocity for machine tool and other similar applications.

AF#,# AUXILIARY OFF
The AF command turns off any combination of auxiliary ports, when encountered in the command stream, allowing control of other peripherals such as a laser beam for machining.

AN#,# AUXILIARY ON
The AN commands turns on any combination of auxiliary output ports when encountered in the contouring command stream.

CD#,#; CONTOUR DEFINE
The CD command allows entry of a contour definition which will start at the position specified. Any combination of axes may be used in the contour mode.

CE CONTOUR END
The CE command ends the definition of the contour sequence, i.e. terminate the CD mode or ramp to a stop and exit when the contour is executed.

CK CONTOUR END AND KILL
The CK command ends the definition of the contour sequence and stops output generation immediately when executed.

CR#,#,# CIRCULAR INTERPOLATION
The CR command causes the axes defined by the CD command to move in a circular pattern from the entry position. The parameters specify the center of the circle and distance to travel in radians. The CR command is only valid with contours of 2 axes.

CV# CONTOUR VELOCITY
The CV command allows the specification of the contouring velocity.

CX CONTOUR EXECUTE
The CX command causes the PCIx controller to execute the previously defined contour sequence.

MT#,# MOVE TO
The MT command causes the axes defined by the CD command to move to the specified absolute position using linear interpolation at constant velocity.

RQ REQUEST QUEUE STATUS
The RQ command returns the number of entries available in the contouring queue.

PID FILTER CONTROL COMMANDS

The following commands set the PID filter parameters

KP# PROPORTIONAL GAIN COEFFICIENT
The KP command sets the proportional gain coefficient on servo axes.

KI# INTEGRAL GAIN COEFFICIENT
The KI command sets the integral gain coefficient on servo axes.

KD# DIFFERENTIAL GAIN COEFFICIENT
The KD command sets the differential gain coefficient on servo axes.

KV# VELOCITY FEEDFORWARD COEFFICIENT
The KV command sets the velocity feedforward coefficient on servo axes.

KA# ACCELERATION FEEDFORWARD COEFFICIENT
The KA command sets the acceleration feedforward coefficient on servo axes.

KO# OFFSET COEFFICIENT
The KO command sets a DC offset to compensate for torque offset in the load.

KN# INTEGRATION INTERVAL COEFFICIENT
The KN command sets the integration interval. The interval is 2 to the power supplied as a parameter update intervals.

ENCODER COMMANDS

The following are encoder support commands for use with the PCIx.

The following are position maintenance control commands:

ER#,# ENCODER RATIO
The ER command allows specification of encoder ratio by entering encoder counts followed by motor counts, for position maintenance mode. (for digital output only)

HV# HOLD VELOCITY
The HV command specifies maximum position hold correction velocity. This is the peak velocity which will be used while making position corrections.

HG# HOLD FILTER PARAMETERS
The HG command specifies the gain for stepper applications with feedback.

HD# HOLD DEADBAND
The HD command specifies deadband counts for position hold. The PCIx will consider the control in position when the stage is within the specified parameter counts during position correction.

HF HOLD OFF
The HF command disables position hold, stall detection and tracking modes.

HN HOLD ON
The HN command enables position correction.

IP INTERRUPT WHEN IN POSITION
The IP command operates like the ID command, except the interrupt is deferred until the stage is within the specified deadband.

The following commands control the slip or stall detection mode.

ES# ENCODER SLIP TOLERANCE
The ES command parameter specifies tolerance before slip or stall is flagged in the status register.

TN SLIP TOLERANCE KILL ON
The TN command enables additional action taken by the encoder slip tolerance system when the position error exceeds that specified by the ES command. When this mode is on, the controller will flush the command queue, terminate the motion, set the slip flag and disable position maintenance for that particular axis.

TF SLIP TOLERANCE KILL OFF
The TF command disables the TN command.

IS INTERRUPT ON SLIP
The IS command will enable interrupts to the host when the position error during a move exceeds the parameter specified by an ES command. The interrupt will occur if the done interrupt has been enabled in the control register. A bit in the status register is also set to flag the source of the interrupt.

RL RETURN SLIP STATUS
The RL command returns the slip detection status of each axis. An S is returned if slip has occurred for that axis, or else an N is returned.

The following command controls the tracking mode of the controls.

ET ENCODER TRACKING
The ET command turns on the encoder tracking mode. The axis will track its encoder input, thus allowing one axis to follow the activity of another or a thumbwheel for manual positioning or the movement of another device that produces a signal compatible to the encoder inputs.

The following commands control the home sequence when used with an encoder.

HE HOME ENCODER
The HE command enables the encoder index mode, i.e. home is defined as the logical AND of the encoder index, the external home enable and the encoder quadrant.

HS HOME SWITCH
The HS command enables non-encoder (switch only) home mode.

The following commands return status information about the encoder to the host.

EA ENCODER STATUS
The EA command returns the encoder status of the currently addressed axis.

RE REQUEST ENCODER POSITION
The RE command returns the current encoder position of the currently addressed axis in encoder counts.

VELOCITY STAIRCASE COMMANDS

The following commands describe the velocity staircase mode. This mode is useful in applications requiring a change in velocity at a prescribed position without stopping.

MP MOVE POSITIVE
The MP command sets the direction logic to move in the positive direction.

MM MOVE MINUS
The MM command sets the direction logic to move in the negative direction.

MV#,# MOVE VELOCITY
The MV command causes the motor to run to the new absolute position at the specified velocity. A velocity staircase may be generated by queuing a sequence of MV commands.

SP# STOP AT POSITION
The SP command will cause the axis to stop at the specified position.

FP# FORCE POSITION
The FP command will flush the command queue and attempt to stop at the specified position.

MACRO CONTROL COMMANDS

MD# MACRO DEFINITION
The MD# command allows the user to combine several commands into one of 25 macros.

MX# MACRO EXECUTE
The MX command allows the user to execute a specified macro.

PROGRAMMING EXAMPLES

In a typical move requirement where it is desired to home the stage then move to a specified position, the following will demonstrate the programming:

Initialize the velocity and acceleration parameters to a low value suitable for homing. Set a PID filter proportional gain of 20, an integral gain of 1, and a derivative gain of 45. Perform the home operation initializing the position counter to zero.

Initialize the velocity and acceleration parameters to perform a faster motion and move to an absolute position of 10,000 counts from home in the negative direction and set the done flag when finished.

The following would be input from the host computer:

```
AX
VL1000 AC10000
KP20 KI1 KD45 HN
HM0
VL5000 AC50000
MA-10000 GO ID
```

In a move requiring a three axis coordinated move to a position in free space the following could be used:

```
AX KP2 KD6 HN
AY KP2 KD6 HN
AZ KP2 KD6 HN
AM
VL5000,5000,5000;
AC50000,50000,50000;
MA1000,2000,3000; GO ID
```

The controller would calculate the relative velocities required to perform a straight line move from the current position to the desired position.

The following demonstrates cutting a hole with a 10,000 count radius using constant velocity contouring and circular interpolation:

The contouring velocity is set to 1000 counts per second. A contour is defined beginning at coordinates 0,0 on the Z and T axes.

Auxiliary output on the X axis is turned on, which could turn on the cutting torch or laser starting the cut at the center of the circle.

A half circle is cut from the center to the outside of the hole positioning the cutting tool at the start of the hole.

The hole is then cut, the torch turned off, the stage stopped and the contour definition completed.

The stage is then positioned and the contour definition executed.

The following would be input from the host computer:

```
CV1000
CD,,0,0;
AN0;
CR0,5000,3.1415926
CR0,0,6.2831853
AF0;
MT-10,10000
CE
MT,,-1000,0; GO
CX
```

SPECIFICATIONS

Velocity

0 to 1,044,000 counts per second simultaneous on each axis

Acceleration

0 to 8,000,000 counts per second per second

Position range

67,000,000 counts (±33,500,000)

Accuracy

Position accuracy and repeatability ±0 counts for point to point moves
Velocity accuracy ±0.01% for step pulse output

Environmental

Operating temperature range: 0 to 50 degrees centigrade
Storage temperature range: -20 to 85 degrees centigrade
Humidity: 0 to 90% non-condensing

Power

+5VDC at 1 amp typical
+12VDC at 0.1 amp typical
-12VDC at 0.1 amp typical

Dimensions

6.875" x 4.200" x 0.500"

Communication Interface

Meets all signal specifications for PCI bus specifications Rev. 2.2.

Limit switch inputs

Opto-isolated TTL input levels (Opto, max 50mA). Input sense (low or high true) selectable by command input for each axis.

Home switch inputs

Opto-isolated TTL input levels (Opto, max 50mA). Input sense (low or high true) selectable by command input for each axis.

User definable I/O

Up to 12 bits of user definable I/O. All bits are optoisolated. Up to 4 are fixed as outputs. 8 bits are user configurable that are configured as 4 inputs and 4 outputs from the factory. The optocoupler is a Sharp PC3Q67Q with a maximum input forward current of 50mA and a maximum output emitter-collector voltage of 35V and 50mA collector current.

Analog outputs

+/-10V and 0 to +10V, max. 1µA each.

Step pulse output

Pulse width 50% duty cycle. Open collector TTL level signal (7406, max 48mA).

Direction output

Open collector TTL level signal (7406, max 48mA).

Encoder Feedback

Maximum 4 MHz after 4x quadrature detection.
Differential TTL level signal (MC26C32, max 15mA).

Compliance

Components and materials for the manufacture of this product are within the RoHS directive requirements.

Reference:

PCI specification, Rev. 2.2
PCB Mechanical specification, IEEE 1101.1, 1101.10 and P1101.11

CONTROL SIGNAL CONNECTOR (J2)

Pin	Description	Pin	Description	Pin	Description	Pin	Description
1	GND	18	PHB+Y	35	5V	52	YNLMT
2	I/O1	19	PHB-Y	36	I/O0	53	Y_HOME
3	I/O3	20	AGND	37	I/O2	54	5V
4	I/O5	21	INDX+Z	38	I/O4	55	ZANG
5	I/O7	22	INDX-Z	39	I/O6	56	STEPZ
6	GND	23	PHA+Z	40	5V	57	AUXZ
7	INDX+X	24	PHA-Z	41	XANG	58	DIRZ
8	INDX-X	25	PHB+Z	42	STEPX	59	ZPLMT
9	PHA+X	26	PHB-Z	43	AUXX	60	ZNLMT
10	PHA-X	27	TANG	44	DIRX	61	Z_HOME
11	PHB+X	28	INDX+T	45	XPLMT	62	STEPT
12	PHB-X	29	INDX-T	46	XNLMT	63	AUXT
13	YANG	30	PHA+T	47	X_HOME	64	DIRT
14	INDX+Y	31	PHA-T	48	STEPY	65	TPLMT
15	INDX-Y	32	PHB+T	49	AUXY	66	TNLMT
16	PHA+Y	33	PHB-T	50	DIRY	67	T_HOME
17	PHA-Y	34	GND	51	YPLMT	68	5V

OMS PCIx(PCI) Intelligent Motion Controls

MODEL	SERVO AXES	STEPPER AXES		USER I/O
		CLOSED LOOP (Encoder)	OPEN LOOP	
PCIx-002			2	10
PCIx-020		2		10
PCIx-202	2		2	12
PCIx-200	2			10
PCIx-004			4	12
PCIx-040		4		12
PCIx-400	4			12

ACCESSORIES

MODEL	DESCRIPTION
(ON REQUEST)	DLLs and drivers for Windows NT, 95, 98 and 2000
USER'S MANUAL	1 Manual & corresponding disk per shipment provided, unless requested

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